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☞ An asterisk (*) denotes an illustrated article

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WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

Subscribers would confer a favor upon us by remitting *CHECKS*, or *POST OFFICE MONEY ORDERS*, as we are frequent losers where money is enclosed in letters.

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STEAM TURNED ON.

At 1·22 P. M;, on May 10th, A. D., 1876, the President of the United States of North America, and the Emperor of Brazil, turned on the steam, and started the great Corliss engine which put in operation the wheels of 14 acres of machinery at the Centennial Exhibition in Philadelphia, and the opening is an accomplished fact. Of the success of all the preparations that had been made for this great event all our readers have been advised by the daily press. Nothing could have been better than the promptness with which everything seemed to move at the appointed time, and the testimony of many foreigners who are competent to judge, seems to establish the fact that no world's fair, or exposition, held heretofore, was ever in so advanced a state of readiness at the opening as this.

The Exhibition is now started under most favorable auspices. Every citizen of the Republic has a vital interest in its future. We have invited the world to visit us; and it is to be hoped most sincerely that when they come we shall receive them warmly, respectfully, and in an earnest, dignified way. Every citizen who can possibly arrange to do so, should at some time visit the exhibition. It is no ordinary show; but here we may learn not only what progress we have made ourselves, but, at the same time, learn what others from abroad have done.

It is not in the spirit of self-glorification that we should view this matter, but with a desire to better know the world at large, and thereby obtain a truer, broader, higher standard by which to judge ourselves.

By coming in contact with others we have many of the roughnesses of our own characters smoothed down and polished, and, in many cases, a conceit supposed to be an honest one is discovered to be unfounded.

It is to be hoped that, although the times are dull, all will take *more* than a passing interest in what is now going on in Philadelphia, and will take a peasonal part in the exhibition. It is not the province of this Journal to chronicle the news of the day, except so far as our specialty may be concerned; but upon an occasion of this kind, we deem it fitting to allude to this event, not only as it regards our own special branch of science, but in its most general sense. One of the most prominent parts of the opening ceremonies was the music, and the representatives of 35 Nations listened to it. The national airs of all the leading nations of the world were performed to the evident satisfaction of those of each who were present. The singing of Whittier's hymn, by the choir of one thousand voices, was one of the grandest points of the whole.

To those who could not be there to hear it, and to those who care naught for music, we would commend the words of this National Hymnn, as worthy to be remembered—especially the last lines.

"For Art and Labor met in truce,
For Beauty made the bride of use
We thank Thee, while, withal we crave
The austere virtues strong to save,
The Honor proof to place or gold,
The Manhood never bought or sold.

O! Make Thou us, through centuries long,
In peace secure, in justice strong;
Around our gift of freedom draw
The safeguard of Thy righteous law;
And, cast in some diviner mould,
Let the new cycle shame the old."

There is no course in life which, guided by the principles set forth so beautifully and simply in these lines, may not result in making the world better for our having been in it. In business or in pleasure, in public or private station, he who maintains "The honor proof to place or gold," lives to a wise purpose and the benefit of mankind.

Most heartily do we wish the Centennial Exhibition God speed. Before it is over we hope to meet many of our readers both from foreign lands and our own. There will be many things in connection with the gas world to be studied there, and we hope, from time to time, to give our readers some account of them. The classification and the judges upon each class, as finally decided upon, are not yet announced, but when they are we will give them to our readers.

MR. HARCOURT'S LECTURE.

We give in our columns this week the very interesting lecture of Mr, Vernon Harcourt, before the Society of Arts, March 31st, in part.

He treats of two topics; first, of sulphur tests (which portion we give in another column to-day) secondly, the standard illuminating power. While this method proposed may be scientifically correct, still there are practical difficulties in the way of adopting it. The preparation of a "standard gas," as proposed, must require some skill in chemical manipulation, which, although easy enough to those familiar with the laboratory, might not meet the wants of many persons charged with the manufacture of gas. The London *Journal of Gas-Lighting* makes the follow-

ing remarks upon the proposed method, and they seem to us to give the "gist" of the matter.

"The interesting lecture delivered by Mr. Vernon Harcourt, at the Society of Arts, will be read with pleasure. The lecturer has thoroughly identified himself with gas interests, regarded from a scientific point of view; and his appointment as a Referee has always been a source of satisfaction to us. His arrangement of a "sulphur-test" may take its place beside the jet photometer, as a guide to a manager. Mr. Harcourt's proposed method of estimating the illuminating power of gas is, we fear, a display of mistaken ingenuity. By all means, let us have a rigidly exact method, if we can; but how can it be obtained, unless by Mr. Crooke's torsion balance? To our minds, Mr. Harcourt's standard gas is open to all the objections made to standard candles. We question whether any number of fractional distillations will give us "pentane" and "hexane" in a constant state of purity, and very small variations in their proportions will alter the illuminating power of the standard gas. So it comes to this, that every sample of standard gas must be "standardized." And how? By a comparison with standard candles. Well, it seems to us, that we may just as well go on with the candles, and save ourselves a world of trouble. There is another point, to which Mr. Harcourt should give some attention. Supposing the coal gas, under examination, not to equal the sixteen-candle standard gas, how is the actual value of the former to be determined? A gas company is subject to a heavy fine for a deficiency of half a candle, and it would be necessary to express exactly the actual amount of deficiency. Candles, we know, are open to many objections; but their employment is made compulsory by all gas Acts, and we do not see how it can be abolished. Will Mr. Harcourt draw us a clause, for insertion in the Regulations Bill, defining the quality of the gas to be supplied to the Metropolis, as estimated by his "standard" gas, and describing in what way penalties for deficiency are to be assessed? That may give the method a practical turn, which will commend it to further notice. But we shall still believe that properly-made candles, in the hands of skilled and careful operators, offer the best means of estimating the illuminating power of a gas. Scientific refinements are out of the question in such a matter as the photometric valuation of a gas. We want a rough-and-ready method, easy of application, the results of which can be expressed in definite and intelligible terms, and such a method is afforded us by the use of candles.

CATHELS'S WORKING DRAWINGS.

By reference to our advertising columns it will be seen that Mr. E. S. Cathels, of Montreal, has prepared for sale, colored lithograph copies of working drawings for retort settings.

They embrace benches containing from one to seven retorts. Each sheet gives all the details necessary for any intelligent man to put up a bench upon Mr. Cathels's plan. The drawings for each number of retorts are on sheets by themselves; and a separate set of specifications accompanies each sheet. From the Annual Report of the New City Gas Company of Montreal, with which Mr. C. is connected, (which is before us) we see that his company's sales of coke and breeze equalled 45·3 per cent. of the cost of coal carbonized. The price of coke is not given, but this makes an excellent money showing for his settings. We are aware that most engineers have decided notions of their own upon the matter of retort setting; but, nevertheless, we venture to suggest that much may be learned by careful study of this subject, and we bespeak for Mr. C. a large sale for his drawings. The price is $30 (currency) for each sheet and accompanying specifications.

Prize Offered for Improvement in Purification of Illuminating Gas.

The Association of Engineers for Gas and Water-Supply in Germany offers, through the commission appointed at the XV annual meeting, a prize of 1500 Marks (about $480) for a new method of removing, in a better and cheaper manner than heretofore, carbonic acid from illuminating gas, or for an improvement in the present methods.

The purification of illuminating gas by hydrated lime does not fulfill all the requirements demanded by practice. It is expensive, and the removal of the spent material is combined with too much annoyance and trouble. Neither do other methods lately introduced fulfill all requirements, but also require further improvement.

The new method must be cheaper, more perfect, and capable of more general application, being intended to increase the candle power, it must not act detrimentally on the light-giving particles of the gas.

The essay has to give a clear description, and a scientific development, of the manner of action of the method, and to show the practical application in such manner, that the same can easily be tested and experimented on, by being inserted in the apparatus of large works.

The commission has the right to test the method in a thorough manner practically. The same has to decide the manner of testing, and superintends the test, also to determine the duration thereof, which shall not exceed six months. The commission has to decide which of the proposed methods shall be admitted to the practical test.

The commission to decide, after the test, upon the value of the proposed methods, whether for one or more the entire prize, or whether a part thereof shall be awarded to different competitors.

The commission will endeavor to increase the amount of the prize to a larger figure, in which case the higher figure will be substituted for the first, and will be awarded in the same manner.

The essays sent in must not bear the name of the inventor, but must only have a sign or motto. An accompanying sealed envelope, with the same sign or motto, must contain the name and exact address of the competitor. Only those envelopes will be opened which bear the mark or motto of those proposals whereon the whole or part of the prize has been awarded. The others will be returned to the writer, in case there is, on the back of the envelope, an address whereto it can be returned. These proposals will be returned as soon as possible after the prize has been awarded. Proposals without address remain for one year in the archives of the Association at the disposition of the writers. The inventions whereon the prize has been awarded will remain the property of the inventors, without interference with the sale to gas companies of patent rights, etc. The award of the prize only to constitute an honorable mention and recommendation on the part of the Association.

The prize will be paid from the funds of the Association as soon as possible after the award has been made.

The results of the tests to be reported by the committee at the next annual meeting of the Association, and to be published in the following number of the "Journal fur Gasbeleuchtung."

Praposals must be sent in by the 31st of December, 1876, to the chairman of the committee, Dr. Schilling, in Munich.

The Committee—

Dr. Schilling, Munich, Chairman.
A. Buhe, Dessau.
A. Mohr, "
E. Grahn, Essen.
S. Schiele, Frankfort-on-the Main.

Explosion at Gas-Works in Holland.

[Translated for the American Gas-Light Journal.]

By T. H. Muller.

The following correspondence of the "Journal fur Gasbeleuchtung" may be of interest to our readers:

Utrecht, Feb. 20, 1876.

In the last months of the past year, the pressure in the purifiers became excessively high, which increased so much that when the production increased to 1900 cubic meters, the water was repeatedly blown out of the cups. As the works here have suffered for years from stoppages by naphthaline in the pipes, it was soon ascertained that the same was the case this time, and the stoppage was located between the station meter and the holders.

Although the locality of the stoppage could be pretty accurately ascertained, it was not deemed advisable to open the manholes provided in different localities, at the time of the largest consumption, to scrape out the naphthaline. Neither was the application of steam, to blow out the naphthaline, deemed advisable; as thereby the same might have been transferred to the elbows below the station meter, and thus stopping off the holders altogether.

I concluded to work ahead until the production could be somewhat reduced, to gain a few hours for cleaning the pipes thoroughly, although the work could only proceed under constant anxiety. I deemed this course safer than to run the risk of a short supply of gas.

But, in the last days of December, the pressure increased in such an alarming manner that I had to clean the pipes. On the 3d of January preparations were made to introduce steam, previously passed through naphtha, into the pipes—which had proved an excellent remedy before.

As there was reason to suppose that most of the naphthaline was located in the elbow under the meter, the cover was removed from the nearest manhole, in order to free that elbow from it. Although the hole was open only a few seconds (dimensions—25 centi-meters long, and 20 centimeters wide=12" by 10") a large amount of naphthaline was removed; but, at the same time, a large quantity of gas escaped. This gas filled, at first, the building behind the meter—which is used for the preparation of lime, and from this was carried by the draft therein into the retort-house. The latter joins the first building, being separated therefrom by a wall with ventilator-openings, through which the gas must have escaped into the retort-house; it there ignited, producing an explosion which demolished the building and transformed the house into ruins.

At the moment of the explosion, happily, the manhole was closed again, so that further mischief by the flame was prevented; but seven laborers were more or less injured by being burned around the head, without any serious consequences, however, as they all quickly recovered. Unfortunately, there was no diminution of pressure after these dearly paid-for efforts, and so all charges were regulated so that, on the morning of the 9th, at 8 A.M., all fires were out, and the manholes could be opened without danger. The ten inch outlet-pipe from the meter here only showed an opening of four inches. The stoppage occupied a length of eight meters, with about twenty-five kilograms naphthaline. After this naphthaline was removed our troubles ceased.

The works in this place suffer very much from naphthaline; all remedies so far employed for the avoidance of this nuisance unfortunately have proved failures.

The employment of difierent coals, such as Holmside, Primrose, Mikley, Burnhope and New Pelton (the latter used at present) has produced no different result. In Colbourne's Treatise —"The Gas Works of London"—it is mentioned that the addition of a few thousand feet of gas from Wigan or Methyl cannel coal—better still of Boghead cannel—to the daily production, will clear the pipes stopped by naphthaline in a short time.

If this remedy should actually prove effective, it would remove in a simple manner a serious nuisance and prove worthy of serious consideration. In case any gentleman of the fraternity of gas engineers is in possession of data on this subject, he will confer a favor on many in similar circumstances, and oblige them and me by publishing them.

A. C. Spruyt.

Cost Price of London Gas.

To the Editor of the *Pall Mall Gazette*—

Sir—The cross purpose between the Board of Trade and the Metropolitan Board of Works with reference to the Metropolitan Gas Co.'s Bill will be far from an unmixed evil if it leads to the determination on the part of the public to arrive at a thorough knowledge of the facts that regulate the actual cost of manufacturing gas in London and of the elements which tend to enhance the price of the supply of this great necessary of life to the consumer.

I propose, with your permission, to show what is the actual cost of manufacture, so far as this is to be ascertained from the last published accounts. It will thus be easy to ascertain what price per thousand cubic feet is charged, or ought to be charged, in order to provide for dividend or interest on the capital invested in the manufacture.

According to the figures compiled by Mr. Firth, the sum paid in the year 1873 for coals by the nine gas companies which supply London was £1,773,701. The number of tons of coal carbonized was 1,444,966. This gives an average price of £1 4s. 6¼d. per ton of coal delivered at the gas-works. In the present week the price quoted for Wallsend coals on board ship in the river Thames is 17s. 3d. per ton. The prices charged by the coal merchants for the same description of coal delivered at the house of a customer is from 28s. to 29s. It is thus evident that much care and skill has been evinced by the managers of the gas companies in making their contracts for coal. We may fairly take the price thus arrived at as a normal figure for the calculation of the prime cost of gas. In the second place, we find that the above quantity of coal produced very nearly thirteen milliard cubic feet of gas. This is the quantity which the companies calculate that they have manufactured. The sales, however, only amount to about 12¼ milliards of cubic feet; the difference of 1¼ milliard said to be made but not accounted for being probably chiefly due to leakage. It is clear that a loss of 10 per cent., the cost of which must fall upon the consumer, is a feature that demands very serious attention, and that in a reorganization of the mode of distributing gas, such as is contemplated in any attempt at reform considerable saving may be anticipated in the matter of waste. Taking the quantity of gas actually manufactured, and comparing it with the weight of coal carbonized, it will be seen that a ton of coal has produced, on the average, 9,660 cubic feet of gas. This is a rate of production which (excluding the special case of cannel coal) may very favorably compare with those obtained in the various country gas works.

It thus appears that, both with respect to the provision and the manipulation of coal, the London companies are fully up to the level of the engineering science and the commercial foresight of the day. The sum paid for coal amounts to 64 per cent. of the total expenditure of the gas companies. The details of the remaining 36 per cent. are not exactly to be ascertained from the accounts; but manufacture appears to have cost 19 per cent., distribution 5¼ per cent., and management, salaries, and director's fees together, a little over 7 per cent. This last item is one on which sensible reduction might be fairly expected from the introduction of unity of organization. It is, however, only on less than a tenth part of the expenditure of the companies that reductions can reasonably be anticipated from improved organization. The sale of gas, which in the first instance was looked to as the main source of the income of the gas companies, is now eked out to a very considerable extent by the sale of residual products arising from the manufacture. When the early Gas Bills were passed, most of these products, with the exception of coke of an inferior quality, were not only valueless but absolute nuisances to the manufacturers. The advance of chemical science, however, has caused the former waste to be utilized to such an extent that the gas companies now derive 19 per cent. of their total income from the sale of residual products. Thus the sum of a little over £700,000 per annum has either to be deducted from the total expenditure of two and three quarter millions or, if that figure is left undisturbed, to be added to the £2,900,000 received by the companies for the sale of gas. If we adopt the former method of stating the account, we find that the total cost of the gas manufactured and distributed in 1873 (after deducting the sales of residual products) stands at about two millions sterling. (The exact figure is £2.055,076.) Taking the previously mentioned quantity of gas manufactured, the cost per thousand feet was therefore 34.28 pence (say two shillings and tenpence farthing). And if we are justified in assuming that the photometric value of the gas supplied was equal to the prescribed standard of sixteen candles, we find that the cost price of the manufacture of the London gas was 2.14d. per candle per thousand feet. Under any circumstances the proper rate of interest on the capital invested in a manufacture is a legitimate addition to the cost price out of pocket. The determination of that rate depends, however, on several conditions. The current value of money is one of these; the credit of the borrowing party is another. When the security is perfect, the money can be obtained at a low rate of interest, as in the case of the English Funds. When the element of speculation enters into consideration, the rate of interest advances in proportion to the degree of risk run, or rather in proportion to the public estimate of that degree of risk. For this reason an amortization, or sinking fund, is either openly added to the rate of interest proper, which is the method usually adopted in France, or the same result is obtained by an increase in the rate of interest, leaving the trader to take care of himself in other respects, which is the ordinary method in England. In either case the borrower pays an increased rate. But in the former method he secures the advantage of the gradual and almost imperceptible extinction of his indebtedness. In the latter, while probably paying quite as much, he remains indebted forever. Unfortunately for the metropolis, the latter method has been that according to which the Legislature authorizes the subscription of the capital of the gas companies.

The total capital invested in the nine metropolitan gas companies in 1873 is stated at £8,887,286, of which sum £7,246,800 enjoys an interest of 10 per cent., while the interest on the remainder varies from 7½ to 4 per cent. In addition to this, the sum of £1,729,912 has been borrowed by the companies at rates ranging from 5 to 4 per cent. (the small sum of £130,000 being rated at 10 per cent.) The total payments on dividend and interest account are stated by Mr. Firth at £981,176. But as this sum comes to about £6,000 more than the united amounts of 10 per cent. on all the share and 5 per cent. on all the loan capital, it is probably somewhat over-stated. The latter and lower amount is equal to a little more than 9 per cent. on the total capital of both descriptions; and accordingly may be approximately taken as the actual incidence, on the consumers of gas, of the charges for capital. There can be little doubt that, with such security as the united districts of the metropolis would combine to give, this amount would be raised, if the question were now an open one, at 6½ per cent.; allowing in that rate of interest for the amortization or repayment of the sum within a definite time. Something like 2½ per cent. on the capital must thus be set down as the loss to the ratepayers and gas consumers caused by improvidence in this respect. This annual loss may be taken in round numbers at a quarter of a million of money. We thus find that, to use round numbers, a manufacturing cost of two millions sterling is raised to a total cost of three millions sterling. The exact sum is given in one place at a little under, and in another at something over, that amount by Mr Firth; but the approximation is near enough for all practical purposes. This is tantamount to raising the price of gas to the consumer from 34d. to 51d. per 1,000 feet. If the charge made for capital were reduced, as before suggested, to a rate of 6½ per cent., the corresponding reduction in the cost of gas would give a price to the consumer of 46.75d. per 1,000. As the standard price proposed in the bill is 3s. 9d. per 1,000 cubic feet, it is evident that a figure has been named which is not only as low as any to which the gas companies are likely to submit, but further as low as, under all the circumstances of the case, the consumer can fairly expect to pay. With regard to the proposed sliding scale, it appears from what has been said that with a cost price of 34d. and a selling price of 45d., about one-fourth of the selling price goes to the capitalist as dividend. If, then, by an advance of 1d. per 1,000 feet, considered as profit all round, the latter gains ¼d., it is a very equitable adjustment that, when the penny involves a loss to the consumer, the capitalist should lose his farthing. If the average dividend be taken at 9 per cent., a reduction of 5s. per cent. (if calculated on the capital, which is probably the intended meaning of a rather ambiguous clause in the bill) does not exactly meet the case. A reduction of 4s. per cent. would, however, be exact; 4s. being the forty-fifth part of £9, as 1d. is the forty-fifth part of 3s. 9d.

I hope, sir, that I have succeeded in showing what the cost price of London gas actually is, and what increment on that price must be due, under any circumstances, to the necessary requirements of the capitalist. That "a proper supply of gas, subject as nearly as may be to uniform conditions," is a fit object to be secured to the metropolis no impartial person doubts. That those conditions should be as favourable as possible to the consumer, provided that public faith if maintained towards the companies, is also undeniable. With regard to the measure intended to advance this result, I hope that it is now clear that the maximum price proposed in the Metropolis Gas Bill is certainly not unduly favourable to the gas companies; and that the sliding scale arrangement merely repuires changing from the figure of 5s. to that of 4s. per £100 to be absolutely equitable.

Your obedient servant, C. E.

—*Pall Mall Gazette, April 24th.*

The Childrens' Hospital *et al. vs.* Henry Bumm *et al.*

[Concluded from page 187.]

After a purifier is charged and put in its place at work, the foreman in the purifying-house will test the gas in it from time to time. The test is performed by the exposure of two strips of paper to a small stream of gas, which is allowed to escape by a cock on the covers of the last purifier put in use.

These papers have been prepared, one for a sulphur test of blotting-paper wet with acetate (sugar) of lead, which blackens quickly if any sulphur be present; and the other, impregnated with litmus or turmeric solution; litmus becoming blue, and turmeric red, if any ammonia exists in the gas.

So soon as the sulphur-test shows the presence of sulphur in the last box, it is time to change and bring into action, as first and second purifiers, those which will take their place in due sequence, and which have not been so much "fouled" as to cease to act properly; and it results from this changing, by test, that there will not be a change of purifier each day, but only whenever necessary; the construction of the apparatus, however, having been planned for proper distribution of labor, to give a daily change to each set, when in regular work.

The test having giving the legitimate indications the last purifier of a set is thrown out to be cleaned; and the centre-valve being shifted, a large nozzle (which is to be found on each cover) is opened to release the gas which is enclosed in the box, when the cover is lifted by a traveling apparatus for the purpose ("carriage") and transported away "over the boxes in use); and after an interval of time for the dissippation of the enclosed gas, the workmen commence the removal of the "foul lime."

This foul lime is taken in wheel-barrows and removed into the open air. the place of dumping is forty feet from the purifying-house, in an open yard on the banks of the Schuylkill, about forty feet from the edge of the wharf along the river, and about one hundred and fifty feet distant from Chestnut Street Bridge. The level of the wharf is about thirty feet below the roadway of the bridge, and the level of the purifier-house floor about six feet above that of the wharf. A low wall, forming an angle supports the bank at the dumping place, and the foul lime is deposited in a heap from the top of this wall.

At the time of my first visit to the gas-works, in February, 1876, there was a barge receiving the spent-lime from carts, which were hauling it across the short space of the width of the wharf; on the occasion of a subsequent visit in March, 1876, there was none going away, but a number of laborers were breaking up frozen foul-lime from the bottom of the dump where it had collected. I was told that, generally, there were barges ready to receive the material, but not always, and that sometimes the foul-lime was hauled away in carts and wagons;—whenever a farmer came for it, it was given to him.

To a visitor of a gas works, where the delicate sense of smell is quickly impaired, the foul-lime in the purifiers is not exceedingly offensive, and at the moment of discharging one of the boxes and of the dumping of the material in a heap, the offensiveness is not so decidedly evident; but after short exposure to the air, and especially damp air, or when, having become wet, it is permitted to dry in the sun, the propagation and dispersion of effluvia is disgusting, even to those employed in the works and whose business it is to endure the smell. A somewhat active decomposition of some of the constituents of the foul-lime certainly occurs after exposure to the air, as is evidenced by an increase of heat, and it is certain that this decomposition does not destroy the odoriferous substances.

In the analysis and purification of gas, by the Rev. W. R. Bowditch, (one of the most practical scientific writers on the subject,) 1867, will be found (folio 19 *e seq.*) these words:

"About this date (1844) the use of gas was increasing very rapidly, and gas companies in London and some large towns were sadly encumbered with and troubled about, the lime refuse which arose from purifying their gas. Purified the gas must be. Sanitary regulations most properly prohibited the running of Blue Billy (the foul liquor of the original wet-lime purification process) into streams and rivers. and even, in some cases, prohibited the carting away from gas-works of dry-lime refuse during the day-time. Matters seemed to be approaching a crisis, when, in 1849, Mr. Hills came to the rescue, and introduced sesquioxide of iron as a purifying agent instead of lime"

It should be stated that the figures and dimensions of parts of apparatus at the Market street works are from recollection of statements of the foreman of the works, and from memory of the observations by me. which were gathered in two visits to the works, of about one hour each, and they are not to be accepted as accurate data, but only as conveying to the mind a relative idea of the magnitude, within close limits, to the facts.

[§ § *Five.*] It next will be proper to show what is the approved and best practice in purifying gas at the present time for the purpose of comparison with that employed at the Market street works.

As noticed in the first part of this affidavit, the earliest successful attempt to purify gas was by means of lime water, and except for the difficulty of disposing of the foul water, it would probably have never been superseded.

The wet-lime process consisted in passing the crude gas in small streams or broad, thin sheets through a mixture of lime and water of the consistency of the well-known white-wash.

The spent material had (and has yet when used) all the filthiness of foul lime as usually made, concentrated by about twice the proportion of objectionable substances, added to which is the absorbed ammonia in the watery portion, and the whole is liquid, so that it must be run off from the works.

The labor attending the purifying of the gas, however, after the stirrer, vats, &c., are once established is quite as little as is demanded by the later process of dry lime, and the purified gas resulting is excellent. Although the dry lime process was introduced in England as early as 1845, it was quite thirty years before it superseded generally the wet-lime one in the United kingdom; and, in 1850, in this country, the opinion of most the gas-works managers (then comparatively small in number) was as decidedly against the feasability of purifying by dry lime, as a similar opinion was against oxide-of-iron processes in 1870.

Prof. Chandler says the wet lime process is yet in use at Cork, Ireland, and it is probably also in use in a few other places in the kingdom.

In this country, I think that it is only at Boston that it continues to be used, and the managers of the works are yet well-satisfied with the resulting quality of the gas. I learn from Mr. W. W. Greenough, the agent and treasurer of the Boston Gas Works, "that the foul-lime water after use in the purifiers is run into a close tank, without any exposure to the air, where it is allowed to settle and the water drained off into a dock or tank, where it is again retained and still further clarified, almost all the lime remaining in the dock." It can be averred, without much exaggeration, that the discharge of any foul water into the harbor of Boston will not materially increase its vileness.

The invention of Hills, in 1849, of oxide of iron as a purifying agent, was at once seized upon by British gas-makers; some paid the claimed royalties, others used the material and defended themselves, and many an expensive lawsuit followed. Hills had the satisfaction of winning and of obtaining some remuneration, and at the expiration of his patent his method was so well established that none of the larger gas-works neglected to adopt it, and since that time no considerable works have been built in Great Britain using lime purification alone. It always happens that during the existence (life) of any original patent no improvement is apparently made. This fact arises from the want of interest by those who use the patent, in the publication of what they individually are accomplishing, or improving upon, in their practice; and it followed in this case, as in others, that when, in 1863, Hill's patent expired, there was little record available in this country describing the details of its use, although the process had met nearly universal adoption. I was, therefore, in 1866, glad to avail myself of the opportunity to see how far the oxide of iron process succeeded, and to examine methods of use.

Taking one of the larger works in the kingdom, under management of the highest reputation, for an example; I found at the works of the Birmingham and Staffordshire Gas Company, Hugh Young manager, the process of purification was as follows:—First, "a single purifier with one wooden screen only, on which was two inches of sawdust wet with weak sulphuric acid. After this the ammonia test was perfect; a paper each month [constantly exposed] being taken to show for that month of exposure at the meter no ammonia was present [had been passed]." "Next followed for the removal of sulphur, a set of four purifiers, three of the number being in use for the purpose at any one time; each of these purifiers had two trays of oxide of iron, each seven inches deep [the oxide] lasting one week without changing [any one of the purifiers being thus changed each three weeks,] and then requiring three days exposure for revivification, the oxide of iron answering for three or four months before chemical change to sulphate [?] is effected to so great an extent as to impair its action, it is then sent to the chemical works to be used in the manufacture of sulphuric acid. In the bottom of these purifiers is placed one tray of two inches of hydrate of lime [dry lime as ordinarily used], which in the same time becomes snow-white carbonate by affinity with carbonic acid, this lime improves the gas two candles."

This was my first personal observation of the use of oxide of iron, and my time being limited I visited no other works; but after my return to America in March, I made it a matter of great urgency upon managers of works in this country, to adopt the same or a similar process; both to avoid nuisance and reduce the cost of purifying—without success, however.

In January, 1870, I again visited the same works and found some changes, which I communicated to friends in this country, as follows;—"The purification is oxide of iron (red hematite ore from the bank crushed to powder, with one-third its bulk of sawdsut); one ton of ore is used for each five millions of gas. Surface of oxide in purifiers, one-half what I use for lime purification. and the duration before revivification four to six times as long as is usual for the lime to become foul. The layers of oxide used are six to eight inches deep in the boxes, but the oxide must be spread about two or three inches thick on the revivifying floor. No offensive odor is exhaled at any time by the oxide of iron. Of course, the pressure on the purifiers is heavy—fourteen inches of water column in all. The seals of the boxes are two feet deep and the boxes four feet three inches deep, and three layers of oxide are used.

"The arrangement is a pair of ammonia purifiers, 16' by 16' by 3' or 4 feet, one of which is used alternately for removal of ammonia from the gas, giving to two sets, of four each, oxide purifiers, 20' by 20' by 4' 3" (of these oxide purifiers only three of each operate at once), and the gas from these two sets to one (of a pair of) carbonate purifiers 16' by 16' by 3' or 4' In the ammonia purifier, sawdust damped with sulphuric acid was used; one of them is emptied once in three weeks. With this precaution the ammonia-test is absolutely perfect. The sawdust is supplied and removed for nothing. A lime purifier is changed each three or four weeks, and the removal of carbonic acid was nearly perfect at all times. The lime could be reburned, but the farmers took it away at prices which paid for new burnt lime. The sulphur-test was below inspection allowance always, and the gas was sixteen candles. There is no secret, mystery or trouble with oxide-of-iron purification."

These works are about half the size of the Philadelphia works. There are, or were, two companies in Birmingham and Staffordshire Gas Company is down in my notes as thirty miles extreme length and ten miles extreme width, with three principal works, and a make of one thousand millions per annum; and with over three hundred miles of connected mains.

In the Paris Gas-Works, at La Villette, the material known as "Laming process" is in use, being a mixture of prepared oxide—that is, oxide of iron made from copperas (sulphate of iron), wood cuttings from a planing machine, and slacked lime in proper proportions. I find notes of this:— * * * "The revivifying-room was strong with pure ammonia, but there was not the least offensive smell in all the works." * * *

It would be possible for me to quote from my notes the process and a description, with proportions of the apparatus for purifying, at several works, in London particularly, but it would only exhibit a repetition of the same general facts, and it is sufficient to say here that all my observation, with the best-known works, failed to impress me any more favorably than those at Birmingham did. Since 1870, the progress of coal-gas making has changed very little, but numerous publications have been made, in which the actual practice of gas purification with oxide of iron and its adjuncts has been well described; accompanied, to be sure, by more brilliant notices of schemes, which make it difficult for a man to distinguish between real performance and projected expectation.

The introduction of the use of oxide-of-iron purification in the works of the United States is yet very rare, but for some two or three years back the system has been employed at the New York Gas Works, in New York City, where a patent mixture of St. John and Cartwright is in use, and also more recently, at the Mutual Gas Works, another oxide-of-iron mixture is used, which is understood to be under another patent or to be a secret. On the 17th of February last I visited these works.

At the New York Gas Works, which are located on Avenue A and East Seventeenth street, (occupying two or three blocks or parts of blocks on and near the East River,) I found the ordinary compartments of a modern well-planned gas works. The operations of the works were transacted with usual care, order and with much regard to avoid or prevent any nuisance. The several settings of benches I was told aggregated eight hundred retorts (13" by 23" by 9'), and two hundred and sixty pounds of coal was used with five changes in twenty-four hours. It was at these works that I first saw the mechanical charger before referred to. The emanations from coke-quenching and retort opening and charging, escaped at the ventilators, but as the works are on the level of the adjoining streets the steam and smoke ascends and is dissipated so as to avoid cause of complaint.

There were two sets of purifiers, twenty feet by twenty-four feet on the floor, by five feet deep, having two feet seals for the covers; with a thirty-inch main pipe and twenty-four inch branch to, and from, each set of purifiers. The purifiers had a single layer screen, each with a bed of oxide preparation twenty inches in depth. The preparation was said to be oxide of iron, iron-borings, charcoal and I think lime. The beds of oxide preparation in the three purifiers gave but two inches of water column as the resistance pressure, as exhibited to me; and the time of service of a bed before it was fouled (for the full production of the works —about twenty-five thousand cubic feet per day per set of purifiers) was said to be three to four days. or about eight millions cubic feet of gas would pass a set of purifiers before a bed would require revivification.

The reviving of the preparation was done in a yard and in an old deserted and open retort building adjacent to the purifying house The material was heaped as usual, for other oxide, one day, and gradually spread to avoid the excessive heat which attends a more complete exposure to the air.

The odors attending this revivification were much less obvious than that accompanying the handling of foul lime at Philadelphia, although not so strong with ammonia as I have generally found at pure oxide heaps. They were using an "enricher" of ten per cent. of cannel coal to bring the gas up to sixteen candles quality, indicating a somewhat imperfect removal of carbonic acid.

It should be stated here, that good Westmoreland or other American gas-coal will yield, with careful charging of the coal into the retorts, quite four and one-half cubic feet of gas (of sixteen candles quality) to the pound of coal; and if any coal, by weathering or otherwise, fails to give this quantity for the yield, it is customary to put in, as part of the charge, a portion of coal (like cannel) which will of itself alone. be capable of giving gas of twenty-four to thirty candles quality; and this act is called "enriching."

I next visited the Mutual Gas Works, Eleventh street and Avenue D, on the East River. At these works they have in all ninety-five benches for coal-gas, with six retorts to each bench, and nine benches for naphtha-gas, also with six retorts to each bench. The retorts were 13" by 24" by 9'. The largest quantity of gas possible, was made from the coal-retorts—or a little over five cubic feet per pound, on the average for the year's work; and this gas was then *enriched* by naphtha-gas of forty-candle quality, to bring the whole gas delivered from the holder up to twenty-candle quality.

The usual work of the retort-house here, presented no subject for comment. The washer and condenser rooms might have been a parlor for all the odor allowed to escape; the washing was done partly or wholly with ammonia water. There were two sets of purifiers, each twenty feet by twenty-four feet on the floor, by three feet deep, with twenty-inch seals. In these purifiers there is but one layer of an oxide preparation, twenty-eight inches in depth.

The preparation was a secret one, perhaps patented, and the gas was perfectly satisfactory for sulphur purificatien, the same prepared material had been in use over a year, and the purifiers required changing once a week or so.

An inspection of the revivifying floor was much more satisfactory to the nostrils than that previously made at the New York Gas Works, but a slight gas-effluvia was present—that is, such a smell as attends gas-lime as distinguished from the ammonia-vapors of pure oxide of iron revivification, I came away from these works without a trace of odor in my hair or clothes; while the result of two visits, of similar duration, at the Market street works was, that at both times the odor brought away was persistent and obnoxious to an excessive degree, remaining attached to clothing for two or three days afterwards.

It is proper to say, that as a naphtha-gas is used for enriching, the gas of the Mutual Company is, in some measure, independent of the presence of non-luminants, since a little more of the naphtha-gas will over come this cause of imperfection; and, also, that the naphtha gas is an experiment of yet undetermined result. Former attempts to supply mixed gases and "carburetted gas" have terminated unfortunately, from troubles of distribution in the mains or services, or in burning, or by cost of production, or in some unhappy way, to most parties interested.

These examples will serve to show that some processes of oxide of-iron purification are practiced in the United States, and that they are comparatively devoid of objectionable smells. The managers of the two works here instanced, state that the cost of oxide of-iron purification is much less than half that of lime purification.

In the quotations from my notes upon the use of oxide of iron for purification, allusion is only made to the avoidance of odor, and no definite description is given of the process of revivification and its products. To supply that want of completiveness of the notes, I will state, the material is removed from the discarded purifier and wheeled in barrows to a covered floor, where it is first piled in a heap three to five feet in depth. So soon as it is exposed to the air, it commences to heat, and it is therefore banked at first, in order to give a surface-exposure only. The heating is attended with a copious effusion of ammonia-gas, with a trace of naphthaline odor, and a little steam from evaporation of moisture from the oxide, which is usually damp from condensation from the gas. The next day after making the heap, it will be sufficiently cooled to be turned over into rows, and on the following day to be spread in a thin layer. If the floor is large enough to allow this spreading to form a layer of two to three inches thickness, no further turning over is requisite; but the oxide must be raked once or twice on the third day, and if the layer be thin and the oxide manipulated at the proper time, it will have been *revivified* at the end of the third day. The effusion of ammonia occurs only when the oxide is turned over or disturbed, and is of short duration (a few minutes only) after the turning or spreading ceases. The principal chemical changes are substantially inodorous

Some attempts have been made to revivify the oxide in the purifiers without moving it, by admission of air through suitable connections, but they have resulted in failure (I am told) in consequence of the great heat evolved when the pressure of air is sufficient to pass it through the bed of foul oxide.

It must be remarked that the resistance of flow of gas through the purifiers is much greater for the general system of oxide purification than for lime purification; but it has been shown that the requisite apparatus for impelling the gas already exists at the Market street works, and the question of additional power needed to effect the purpose is really insignificant, as the movement of all the gas possible to be made at these works at any time, under eighteen inches of water-column pressure, will not exceed the performance of a ten horse-power engine.

The process of oxide-of-iron purification results in great saving of expense to the gas-maker. At the New York Gas Works it was asserted that the entire cost of purification did not exceed five-eighths of a cent per thousand cubic feet of gas made. It is unquestionable that the use of the oxide process would result in great profit to the Gas Trust from saving of labor and of crude material, and I believe would be highly advantageous to the consumers, in the improvement of the quality of gas made, the value of which would far more than recompense the cost of introducing the process.

There is yet another way to avoid the nuisance proceeding from dry-lime purification, which is exhibited at the works of the Manhattan Gas Company, visited by me on the 16th and 17th of March (ult.). The North River Station of the works of the Manhattan Gas Company of New York, is located on the blocks of ground west of Tenth avenue, on West Eighteenth and Seventeenth streets and adjacent streets. Omitting any general description of the works, only to say that the condensing and washing house was devoid of the least possible odor, I will proceed to a particular account of the system of ventilation of the foul lime resulting from dry lime purification, there in successful operation. At these works they have (for the one thousand and thirty-two retorts in the benches, eight hundred and forty—highest number in use at one time) three sets of purifiers, seventeen by twenty-two feet on the floor, by three and one-half feet deep, with seven layers of lime in each, and the usual connecting pipes of inlet and outlet.

Besides these usual pipe connections for gas, they have likewise connected to the bottom of each purifier, a sixteen-inch pipe with a suitable stop-valve; these pipes join into a twenty-four inch main-pipe, and the latter connects to an exhauster, in this instance a species of screw-fan, five feet in diameter. From the exhauster, a twenty-four inch pipe leads to a jet-washer, which corresponds in construction to that before described at Market street works, only it is but one-fourth the length (that is, ten feet in lieu of forty feet on the floor), the height and width being about the same as the Philadelphia washers. All this part of the apparatus is in close proximity to the purifying

house. From the washer, the pipe continues to a drain-pipe three feet high by two feet wide (egg shape) which leads under the roadway of West Seventeenth street, nearly one thousand feet, to a deodorizing building. This deodorizing building has two closed deodorizing-rooms, with only a doorway for entrance, and on the floor of each room is a brick deodorizer-box, without cover. These boxes are thirty feet long by sixteen feet wide by three and one-half feet deep, and have seven layers, of similar construction to those used in usual dry-lime purifiers. Branches from the main drain-pipe, controlled by valves, open into the bottoms of the brick purifiers; and openings also controlled by valves, from the upper part of the rooms, lead to a chimney seventy feet high. The screens are covered with ventilated spent lime, about one-tenth of all the lime being used at these secondary purifiers. The purpose of this apparatus is the ventilation of the foul lime in the purifiers, and it is effectual in this way:

When a purifier is ready to discharge, and is shut off as usual from the gas-works by the centre-valve, the cover is lifted from the seat and suspended about one inch above the box. The valve of the ventilating pipe is opened and the ventilating exhauster started. Air is sucked into the purifier from the top, and the foul lime is ventilated for one and a half hours, at the end of which time it will be found decomposed and deodorized to such an extent that it can be properly denominated spent lime; at all events, it is devoid of any marked unpleasant odor, and will have ceased to possess the power of originating them. In this condition, spent lime is really available for immediate use for agricultural purposes. During the operation, the lime in the box heats to, perhaps, 140°, and from an approximate estimate, founded on the speed of the fan, (six hundred revolutions per minute,) about 300,000 to 400,000 cubic feet of air will have been passed through the layers of lime.

The wash water is brownish yellow, and not offensive; it is run off into the sewer.

Very unexpectedly, the long drain-pipe main was found to have acted as a condenser of naphthaline, whose presence in great quantity, in foul lime, has no been before noticed. The pipe was coated with naphthaline to the extent of *five or six inches* after a year's use, and it was removed by introducing a jet of steam and blowing it through by means of the exhauster. [It would seem that naphthaline was soluble in steam or vapor of water, while it is nearly insoluble in water.]

Having reached the secondary purifying house, the foul air is passed through one of the rooms and discharged through the chimney into the open air. The deodorizing material in this case was stated to be spent-lime from the gas-purifiers. It was found that pure lime had no effect on the foul air, and at the suggestion of Mr. Carl H. Schultz, chemist, New York, the *spent-lime* was employed with great success The lime on the deodorizing screens is revived in part, by forcing *fresh* air through it for an hour, after the operation of ventilating a gas-purifier has ceased. The lime is customarily changed in the deodorizing-house, for every purifier changed in the purifying-house. This operation is highly satisfactory to the Manhattan Company, and answers to meet all the requirements of the New York Board of Health, which has forbidden the use of dry-lime purification at the gas-works of that city.

[§§ *Six.*] At the Market street works, besides the manufacture of gas, there are two perpetual lime-kilns for the making of oyster-shell lime for use in the purifiers. This branch of the business is not carried on, to my present recollection, by any other gas-works in this or in other countries.

The plant is a very simple one. A stone structure about thirty feet long by sixteen feet broad and twenty-five to thirty feet high, contains two kilns or "stacks," internally cylinders of eight feet or so in diameter, with the lower part reduced to perhaps three feet; square openings from one side permit access to the bottoms or hearths of the stacks. The base of the stacks is surrounded by temporary buildings or sheds. These stacks are situated between the purifying-house and the Schuylkill river, and are about one hundred and fifty, or two hundred feet north of Chestnut Street Bridge; between them and the bridge, the space of wharf is utilized, first by the foul-lime dump, and next, by a pile of generally twenty thousand to forty thousand bushels of oyster-shells (or more).

The operation of making lime in these stacks, is to charge at the top a quantity of oyster-shells, mixed with one-fourth the quantity of coke breeze and fine coke dust; and at certain regular intervals some bars of iron are driven in across the tops of the openings to the hearth, and the burned oyster-shells under the bars, now converted to lime, are *drawn* out; when, removing the bars, the charge falls from bottom to top; and after the stack has once been lighted, the process of burning will go on continuously with regularity.

At first there arises and escapes from these kilns the steam from the moisture of the oyster-shells, laden with the odors of cooked oysters, mingled with those proceeding from decayed remains; and after this, and accompanying it, escapes a volume of nearly pure carbonic acid; together with a little chlorine vapor or gas, and some small quantity of other gases. This carbonic acid proceeds from the carbonate of lime of which the oyster-shells are mainly composed, and from the combustion of the coke, which disappears altogether during the process; and as this gas, at the temperature of leaving the kiln, where the upper layer of oyster-shells and the moisture will have nearly taken up all the heat of burning the coke, which occurs at or below the middle of the stack, has about the same density as the external air; it follows that, although it may diffuse rapidly, yet it does not disipate by ascension. I am informed by competent authority that the height of the approach of the Chestnut Street Bridge, in front of the heap of oyster-shells at the gas-works, is thirty-one feet six inches above top of ground. Consequently, as the tops of these kilns are nearly at the same level as Chestnut Street Bridge, (about two hundred feet distant to the southward,) and of Market Street Bridge, (about three hundred feet distant to the northward,) any current of air up or down the river will sweep these gases and odors directly across them.

The oyster shell heap, near Chestnut Street Bridge, emits disagreeable odors and, speaking of it in the mildest terms, can be generally denominated as offensive to the public. I only state the existence of the heap to complete my narration of the arrangement and occupation of the grounds of the Market Steet Station of the Philadelphia Gas-Works.

III. It cannot be said by any person practically acquainted with the manufacture and supply of gas, and competent to advise on the location of gas-houses, that the Market street works are judiciously situated as regards the main thoroughfares and streets of the city, although the place may give, at this time, great advantages for distribution. The barn-yard and the pig-pen are necessary adjuncts to the farm dwelling, and the farmer is happy in their contemplation; but if the county lays out a road behind the farmer's house, when his barn is outgrown he will be likely to build a new one in another place.

It must be regarded as a grave error that the works were not removed, in place of having been reconstructed on a larger scale, a few years since.

The holders could have been and should have been preserved, and possibly additional ones erected, but after *the entrance* of the city was established by the erection of the passenger station of the Pennsylvania Railroad, and Market street became the important avenue, some reasonable expenditure should have been incurred to have removed the operation of making gas to some other part of the city. And this could have been done by the construction of a single five-foot or six-foot wrought-iron pipe main, at no enormous outlay, considering the importance of the object.

The Beckton Gas-Works, of the Chartered Gas Company of London, which are situated nearly eight miles below the centre of distribution, and where there are two thousand one hundred and sixty double-ended retorts, (equivalent to four thousand three hundred and twenty retorts of the Market street size,) can be taken as an example of the recognition of the comity of the public as weighed against the right to carry on objectionable manufactures in the midst of a city, no matter how necessary to the city itself such a manufacture may be. Any person will tolerate and endure in his shop, laboratory, manufactory or avocation, odors or dust more or less unhealthy and disagreeable, but no one will desire these inconveniences at his home.

ROBERT BRIGGS.

Sworn and subscribed before me, this twenty-fifth day of March, A. D. 1876.

EDWARD S. HARLAN,
[SEAL] *Notary Public.*

Affidavits on Behalf of Trustees of Philadelphia Gas Works.

ROGERS AND OTHERS VS. NATHAN HILLS AND OTHERS.

III.—DECEMBER, 1875.—1047.

Thomas R. Brown, being duly sworn according to law, doth depose and say:

That he is the chief engineer of the gas works under the control of the individual defendants in the above, and has occupied that position since March 27, 1868.

That the gas works referred to in said bill were located in their present position as early as 1835, though large valuable improvements have been added thereto, so that the amount of invested capital therein is over one million of dollars.

That deponent believes that all of the private houses of which complainants claim to be owners have been erected since the establishment of said works, and that they receive their gas therefrom.

And deponent denies that any influence is referable to said gas works injurious to public health; on the contrary, so far as the same is related to the hygiene of the neighborhood, it is positively for good. The absolutely healthy condition of those long employed at said works corroborates this.

During winter, oyster shells are chiefly received at the gas works. They are deposited in heaps and well bleached before put in the kiln. With rare exceptions their conversion into pure lime is free from local objection on account of odor. It will happen that dead animal matter, with the wind favoring such a result will, in the burning, produce an offensive odor. This, however, is of rare occurrence. and almost inseparable from their use.

The purest lime is obtained from the shells, and this is the best for the purification of gas. As yet, no apparatus is known which can convert them into lime and suppress the odor. It is the intention of the trustees, under my direction, to apply a method which I hope will attain this end.

The bill asserts that the trustees do not apply modern and improved methods for the purifiaation of gas. These methods are not specified, nor the works referred to where the same has been adopted. The two prominent methods are by the moist hydrate of lime, which is designated as the lime process, and which is used at the gas works of this city; and that by oxide of iron, which may be designated as the iron process. The latter does not secure as high an illuminating power in the gas, nor are the odors from the used iron less objectionable than those complained of by the plaintiffs. It is far more expensive. Where used the result has not been as satisfactory as that by lime process In this connection the "Report to the Manhattan Gas Company on the Merits of the Lime and Iron Methods of Purification," I would refer to, without needless similar elab oration, which was sent me by their engineer, whose letter I would wish read. I desire that the letter of the engineer of the Jersey City gas works on this subject, to me, may be also

read. I believe that an intelligent examination by experts, who are familiar with the results of actual experiments on a large scale, will be without doubt in favor of the system of purification used at the Philadelphia gas works, although the iron process of purification I shall advise the trustees to test, and I may be authorized so to do. Experiments of this kind cannot be rashly made, and the best method of which I have heard is the subject of patent, and the consent of the patentees must be obtained.

In the gas works there is used yearly not less than 200,000 bushels of lime, which are made at this place. The convenience and economy which the location of the kiln at the works produces cannot be over-estimated. and its removal would be injurious. I am not aware that the trustees could purchase shell-lime if they did not make it themselves, and if the business should be privately carried on by others, it could not be purchased as cheaply as we can make it.

THOMAS R. BROWN.

Sworn to and subscribed before me, this 24th day of March, A. D. 1876.

[Seal.] JAMES J. ALEISON, Alderman.

PHILADELPHIA GAS WORKS,
OFFICE OF CHIEF ENGINEER,
S. W. COR. 22D AND FILBERT STS., April 1, 1876.

Prof. Henry Wurtz:

Dear Sir: I beg leave to submit to your examination the enclosed documents. Believing that your advantages as a gas chemist for obtaining a familiarity (both theoretically and practically) with the history and practice of gas purification have been unsurpassed, I request of you to return me replies, in the character of a scientific expert, to the appended list of questions, such replies to be affirmed under oath according to the proper forms.

Yours respectfully,
THOS. R. BROWN, Engineer.

QUESTIONS.

1st. Please state your profession and past and present position and pursuits.

2d. Have you any connection, public, private, professional or otherwise, which could be supposed to restrain or influence your free and independent expression of opinion upon a public question?

3rd. Have you had special opportunities to study the subjects of gas chemistry and gas purification, and if so, specify these opportunities and produce any documents you may regard as authentic and significant, bearing thereon.

4th. Have you read the documents entitled: Complaint in the case of the Children's Hospital et. al. *versus* Henry Bumm et. al., and the statements of different citizens of Philadelphie, and of Prof. Chandler, Mr. Greenough, and others. And please state how far and in what respects you may concur with or dissent from the same in reference to the chemical, technical and sanitary points involved?

5th. Have you examined the operations of making and purifying gas at the Philadelphia gas works, and do you find evidences that the operations are so conducted as to be exceptionally offensive to the citizens of Philadelphia?

6th. Have you as a gas chemist any suggestions to offer, looking to the satisfaction or mitigation of the complaints of the citizens of Philadelphia, that you have before you; if so, please state them?

No. 12 HUDSON TERRACE, HOBOKEN; N. J.,
April 7, 1876.

Thomas R. Brown, Esq., Chief Engineer Philadelphia Gas Works.

SIR: To the questions you have done me the honor to submit to me, I beg to offer the following answers:

Answers to Questions 1 *and* 2.—My profession is that of a chemist. I claim also to be a general and practical scientific expert. I am a graduate (in 1848) and Master of Arts of the College of New Jersey at Princeton, and studied subsequently in the Lawrence Scientific School at Cambridge. I was subsequently an Instructor in the Scientific School at New Haven; State Chemist and Mineralogist of New Jersey; Professor of Chemistry in the Medical College at Kingston, Canada; Examiner in the Chemical Class in the United States Patent Office, Washington, and Professor of Chemistry in the National Medical College at Washington. More recently I have for five years edited (without stipend) the "American Gas-Light Journal," which, desiring entire independence in professional matters, I resigned a few months since.

My position in the Patent Office and on the 'Gas-Light Journal" gave me peculiar *general* facilities for an intimate familiarity with the past and present history of the gas manufacture in this and other countries.

As editor of the Journal, I was enabled to visit and examine minutely a large number of our most important American gas works, and gain a knowledge of their operations and results.

My present position is, professionally, entirely independent, unbiassed and untrammeled.

I have no connection with any institution, educational or other; hold no appointment in any sanitary or other public capacity; am not and never have been a stipendiary of any gas company, and have no pecuniary interest in any method in use in any gas works, for purification or otherwise.

Answer to Question 3.—In addition to the above *general* opportunities, I have had *special* opportunities, such as this question relates to, for studying the subjects of gas chemistry and gas purification. In the cases of the investigations made by the New York Board of Health into the "Gas Nuisance," I was retained by both the Manhattan and Metropolitan Gas-Light Companies, to examine and report, as a chemist, upon their modes of lime-purification. in comparison with iron-purification generally, and among other things made a eRport to the Manhattan Company in 1868, of which a copy accompanies this statement.

At the desire of the Metropolitan Company, I appeared and was examined upon the subject before the Referee of the Board of Health, and gave testimony which will be found printed in the pamphlet that has been specified by Prof. Chandler, in his statement, entitled, "Report on the Gas Nuisance."

I have, since this, examined professionally the special iron methods of purification (those of St. John and Cartwright) in use at the two large works in New York city, the New York and Harlem, and made experimental investigations. the results of which control in my mind, to some extent, the inferences regarding these special iron methods drawn in my report to the Manhattan Company, these results being on record in the files of the "Gas-Light Journal," and stated also concisely below under *Chemical and Technical Considerations.*

Answer to Questions 4 *and* 5.—I have examined the more important of the documents referred to, with all the care and deliberation that a too-brief period of time has permitted, and believe I have ascertained and fully comprehend all the essential points contained therein. My discussion of them may, I fear, be both less complete and less concise than if more time could have been given me.

I have also made a visit, at my own desire and suggestion, to the Market street gas works, and examined them fully in every part.

I shall make reply to questions 4 and 5 jointly, and divide the subject into the following five heads:

(1st.) Special Circumstances of the Market street works.

(2d.) Nature of the Nuisances involved.

(3rd.) Sanitary Considerations involved.

(4th.) Methods of Purification, and Chemical Principles thereof.

(5th.) Technical Considerations involved.

(1.) SPECIAL FEATURES OF THE CASE.—These are mainly obvious, and need but allusions. Few gas works in the world of so great a magnitude are so situated as these; in close proximity to a resident population many of whom are of an elevated class, and contiguous to one of the greatest thoroughfares on the Continent, and two bridges over which it may be said that the whole people of the United States are liable at any time to pass.

Your works are at the same time of exceptional magnitude, there being but one single station on this Continent (the Eighteenth-street station of the Manhattan Company in New York) which approaches near it in the amount of gas made, and probably but one or two across the Atlantic which equal that amount.

It certainly behoves us, therefore, to consider carefully the matters covered by these questions.

It is just, also, to remember that the march of the increase of your manufacture has been probablo more rapid than in the case of any other gas works in the world.

(2.) NATURE OF THE EXTANT NUISANCE.—The meaning of "*nuisance*" is vague, and varies with the individual using the term.

It *should* mean something hurtful to individuals, which can be remedied without *greater hurt* to the common weal.

This discussion I cannot enter into now. The complaints of the citizens submitted to me claim four sources of nuisance, one of which, the shell-lime kilns, is most insisted on; next, the smell of putrefaction from the shell heaps; next, the smell from the spent lime discharged from the purifiers: and, lastly, the odor from the quenching of the spent coke, as discharged from the retorts.

(*a*) *The Shell-lime Kilns.*—As I am told that these are at once to be done away with, it needs only that I should express my approval of this intention.

The odor of all burning animal matter is notoriously repulsive, and to that extent hurtful to many constitutions; and the fact that such effluvia are evolved in admixture with the heavy gas carbonic acid, which in a quiet atmosphere will settle and spread over the ground, intensifies the objection.

I would refer, with full concurrence, to the testimony of Mr. Greenough (p. 57) on this point.

(*b*) *The Shell Heaps.*—Here I still more fully concur with the complaints made by the citizens of Philadelphia, and must commend the determination to do away with such accumulations of animal refuse, as connected with the gas works, which in all cities are too liable to be charged unjustly with annoyances proceeding from putrid matters, as manure, garbage, etc., to afford to maintain a system which justifies a charge of this kind.

At the same time, I must be permitted to suggest that some exaggerated views appear to my mind, to have been taken regarding this matter.

One medical gentleman has testified (p. 54) that the unhealthiness of the putrid emanations is increased by the heat of the kilns in burning the shells. This surprises me much, as it is a fact well known that the morbific poisons residing in putrid matter are *destroyed*, instead of being intensified, by a heat even as low as boiling water, much more by the heat of the kilns. I do not, however, present this comment in the way of palliation of the system, which I say again should be done away with at once.

(*c*) *The Spent Lime.*—Regarding the complaints under this head, upon which less stress appears to be laid by the citizens generally than upon the odors of putrefaction and burning, there is, nevertheless, much more to be said; as the abolition of the system which gives rise to *these* odors is very far from being such a matter of simplicity as the removal of the oyster shells and lime kilns.

Any change in your mode of *purification* is one which may be said to be *revolutionary* in the whole conduct of your business, and one which requires the utmost circumspection, and the most thorough study and investigation of all the circumstances, internal and external. Under this *present head*, however, we have but to look at the nature of the odors or effluvia evolved under your present system.

In view of the fact that in all previous cases of complaints against gas works by the public, that I am acquainted with, the *spent lime* has been the chief cause of complaint, it was to me a matter of surprise, be-

fore visiting your works, that comparatively so little stress was aid upon this special and characteristic kind of emanation by the residents of the neighborhood.

In other cities, where lime is used for purification of gas—which is the general rule throughout the United States—it has become fashionable to impute *all evil odors* to the spent lime.

On observing the extensive and powerful *condensers* which you possess, however, I recognized the reason why your refuse lime does not evolve odors as offensive and persistent as is often the case. I would suggest that Prof. Chandler and the other distinguished gentlemen who have made the depositions you refer me to, have, probably inadvertently, disregarded the important fact that complete *condensation* of impure matters is of the greatest consequenee in gas purification, and that when this is accomplished, the chief offensive constituents of the impure gas will have passed into the tar and ammoniacal liquor, and that very little is left to be taken up by the lime but *sulphuretted hydrogen*, *ammonia*, *naphthaline* and *carbonic acid*, some of which, though noxious when concentrated, as the physicians of the Children's Hospital have testified, are so rapidly dilated and destroyed by diffusion throughout the atmosphere, that I believe this goes far to account for the extraordinary fact—unparralled, so far as I know—that you have been handling one thousand bushels a day of spent lime, in so crowded a locality as that of your works, with so little *comparative* annoyance to others, as to lead to its ranking below the shell-lime kilns in this regard.

I would also here introduce my reply to that part of your question 5 relating to the production of an *exceptionally* offensive nuisance; and while reiterating my opinion about the storing and burning of the shells—which you are to abolish, as I understand—I would say that among the large majority of gas works, considering their enormous magnitude, I must believe to have been *exceptionally inoffensive*, as regards the spent lime. Nevertheless, more remains to be said upon this point under another head below.

(*d*) *The Quenching of the Coke.*—My remarks upon this, also, I shall defer to other heads below.

(3.) Sanitary Considerations.—It is in every way becoming to the distinguished medical gentlemen who have joined in the complaints you refer me to, to manifest so praiseworthy a zeal in behalf of the community; and in so far as they err, it is of course on the right side. I must, nevertheless, say that I believe some of them do err, in exaggerating the "noxious" character of the legitimate emanations from the process of gas-making proper, including the spent lime (apart from the putrid oyster-shell question).

I would submit that it is, I may say, almost a universal creed at present, throughout their own profession, that diseases, particularly of the diptheritic and typhoid character testified to in the Children's Hospital, proceed from blood-poisons not of a strictly chemical nature, like sulphuretted hydrogen and sulphide of ammonium, but from such as possess a vitality and reproductive character of their own, *ferments* or *parasitic growths*—this being known as the "Germ Theory of Disease" of which indeed the eminent chemist and sanitarian, Prof. Chandler, is a leading and pronounced advocate. Notwithstanding this, some of these medical gentlemen have strongly intimated that the sulphide of ammonium emanations may actually have conduced to typhoid diseases (see p. 8), thus needlessly alarming the community, as I believe. No facts are known to laboratory-chemists or to gas-men, both constantly liable to live in atmospheres strongly impregnated with sulphide of ammonium, that would justify any such supposition.

It is true that this fetid-smelling gas generally accompanies putrid emanations from manure, excrement, sewage, rotting vegetables, etc., being in this case a provision of nature—harmless in itself, like the rattle of the *Crotalus*—to warn us away from the hidden venom of disease, *which itself is totally inodorous.* In the gas-house sulphide of ammonium and other effluvia, no such venom is possible; yet one medical gentleman (p. 31) has deposed in substance, that "the gases emanating from coal-tar and other refuse material from the retorts, on the surface of the Schuylkill river, carry with them germs of disease and perchance death." I assure you that I cannot hesitate one moment to regard this as an absolute misapprehension, as far from the reality as well could be, and a statement which stirkes me with much astonishment, considering its highly respectable source; unless indeed it is an inadvertance.

One other point in the testimony of one of the *chemical* experts I must be allowed to remark apon, under this head. This is found on page 66, where the quenching out of the coke from the retorts is substantially stated "to cause sometimes the evolution of *arsenical compounds*, as the coal *sometimes contains arsenical pyrites.*"

This, if true, would be a fearful note of alarm! It should and would drive all gas works out of our cities without fail. Being sure that this is a mistake, and that it is moreover a chemical, mineralogical and geological impossibility, from the fact that arsenic is wonderfully and exceptionally absent altogether, not only from the older rocks of whose ruins they are made up, I nevertheless have expended some little time to verify this by search. The most complete and precise series of *analyses* of American gas-coals on record is that of Prof. Wormley, who was chemist of the Ohio Geological Survey. It includes some Pennsylvania as well as Ohio gas-coals, and the analyst is himself one of the most distinguished students of arsenic and other poisons, that is, an eminent *toxicologist.* He would not have missed arsenic, if present. I find that in the course of the thirty pages of his report on these analyses, he does not mention the word arsenic. I called also upon the distinguished geologist, Dr. John S. Newberry, of New York, who was the director of the Ohio Survey, and he assured me that arsenic was unknown to him absolutely, as a constituent, in any part of the carboniferous rocks of Ohio and Pennsylvania. I believe this is a spectre that may be considered as laid, regretting only to have had to use so many words in the exorcism.

(4.) Purification-Methods and Chemistry of the Same.—Under this head I must begin with a few remarks supplementary to my appended Manhattan Report of 1868, on Gas Purification, my investigation into the subject having of course advanced, in some respects, in this period of eight years. The modifications I have to make pertain chiefly to the special method of *Iron Purification* known as that of St. John and Cartwright, which is referred to in that report. It was afterwards found by me—upon extended examination of the workings of this method at the New York gas works, after they had *enlarged greatly their condensing facilities*, as well as at the Harlem gas works, where it has since been introduced—that much injustice was done to the merits of this invention in the report referred to. With the *improved condensation*, I found, upon experiment, that the taking up of fetid matters by the iron oxide, to be evolved again in revivification, was reduced to so inconsiderable an amount, that I felt fully justified in testifying (in conjunction with Prof. Chandler) to that effect in a New York Court, in which an accusation had been brought against the New York Gas-Light Company, as producers of a public nuisance, of which they were acquitted, it being found afterwards, as I was informed, that the alleged nuisance came from a neighboring establishment for the manufacture of sulphate of ammonia. This particular American iron-method is of such importance, power, economy and efficiency, and so free from offensive effluvia, that, were it not for special difficulties connected with your works, I would not hesitate to urge that you should examine into and test its operation in New York.

These difficulties will be explained under the next head.

Being a full believer, with the distinguished gas manager, Mr. W. W. Greenough, Agent of the Boston Gas-Light Company, whose testimony I find among the documents you have laid before me, in his opinion that "there is no necessity for a gas works being a very troublesome neighbor," I was nevertheless, desirous to reinforce this opinion by renewed observations upon the working of methods that have been adopted in different gas works, to verify the principle. I therefore made a new visit to the scene of my observations of eight years since, at the Eighteenth street station of the Manhattan Company, where I was received with all politeness by the chief engineer, Mr. C. V. Smith, who exhibited the working of the apparatus for ventilating the fouled lime in the purifying boxes before removal, as has been described in the pamphlet report of 1868. Mr. Smith stated that no essential change has been made during the interval of eight years, no difficulties met with, and no renewal encountered of the former incessant complaint of effluvia from the opened purifiers. As the immense purifying-house (one of the largest in the world) of this station fronts on the Tenth Avenue, a considerable thoroughfare, the test here is very satisfactory.

Learning, however, that an improvement has recently been made upon this ventilating process and introduced with success into the works at Providence, Rhode Island, I immediately started for that place, where the courteous manager, Mr. A. B. Slater, also exhibited the whole process and apparatus to me, with every possible care in explanation and detail. The improvement—introduced, I believe, by the Smith & Sayre Manufacturing Company, of New York city—consists mainly in the use, for the purpose of drawing air through the fouled purifiers, for ventilating and defecating the same, of a *steam-jet exhauster;* the result being that a large part of the sulphide of ammonium and other fetid matters drawn out of the spent lime is precipitated in solution with the water that condenses from the steam-jet, and flows away in liquid form. It is then much easier to remove the remainder of the effluvia before passing into the atmosphere, by means of an ordinary cold water scrubber. To a chemist, seeing this arrangement in operation as I did, its simplicity, efficiency and general value are obvious. Experiments were made in my presence, by filling equal-sized bottles with the air, before and after passing the cold water scrubber, to test the efficiency of this latter in completing the defecation. Some lead-solution introduced into these bottles indicated this by the comparative depth of brown color. These experiments were very satisfactory to me; but it was still more so to actually *inhale*, as I did for some time, the defecated air as it issued from the scrubber. Except for a slight residual naphthaline odor, this air was scarce to be distinguished from the air of the room in which the apparatus stood. This apparatus is also exceedingly compact and inexpensive in construction.

(5.) Technical or Practical Considerations.—It thus appears, that to obviate altogether all possible offence, even to the nostrils of the public, from the spent lime, you have presented to you two plans to choose from, each of which has been found efficient by different large gas companies. One is, to change all your present methods, materials and (to some extent) apparatus for purification, and resort to some mode of iron-oxide purification, as has been urged by several of the gentlemen making the statements to which I have been referred. In regard to this, it is necessary for me to point out that these gentlemen have omitted to consider some undeniable circumstances connected with purification by iron-oxide. One of the most important, and one which concerns you most vitally, is that an essential feature or the iron methods is the continual revivification and re-employment of the material. The revivification is accomplished by spreading it out in a thin layer on the floor of a building reserved for the purpose, and turning it over from time to time to allow of oxidation and restoration of its power. This always requires a considerable *ground space.* In the case of the New York Gas-Light Company, whose maximum make of gas is probably about one million and a half feet per day, quite a large building is devoted to this purpose of revivification. In your case, as your make must be put at nearly four times this amount, a building should therefore be required covering four times

the ground space. This, I scarce need add, is impracticable under the circumstances of your works, there being no adequate space. On inspecting your purifying boxes, also, another practical difficulty appears which has some weight. The mode of using the iron-oxide without trays increases the coercive pressure upon the gas very considerably; and the seals of your purifying boxes would not be adequate, so that new boxes would have to be provided.

Another difficulty in the way of your adoption of iron purification is strongly suggested to me by reading Prof. Chandler's statements. He claims that the carbonic acid which is left in the gas by iron purificatiyn, carries with it no detriment except a decrease of illuminating power; his plan of rectifying which, is to "take less gas from the coal" (page 38). Prof. Chandler has, however, failed to consider that this involves the leaving of the coke imperfectly carbonized; and the inevitable result would be that the nuisance arising from the quenching or wetting of the coke would, considering your crowded location, become intolerable.

The practical conclusion appears then to be that your proper course to meet the emergency and to remove all cause of offence, actual and colorable, covered by the complaints made, is, in addition to the cessation of lime-burning on the ground, to introduce the method of ventilating the spent lime by drawing air through it, preferably in the manner this is accomplished in Providence, R. I.

Question 6th having been virtuallya nswered already, I will therefore subscribe myself,

Refpectfully,

Henry Wurtz.

This affidavit is followed by the report made to the Manhattan Company in 1868, which was published in the American Gas-Light Journal August 17th and September 2nd, 1874.

Some Methods of Estimating the Illuminating Power and Purity of Coal-Gas.

By A. Vernon Harcourt, M.A., F.R.S.

Reader in Chemistry at Christ Church, Oxford, and one of the Metropolitan Gas Referees.

[From the Journal of the Society of Arts]

It is well known that coal-gas which has been purified from sulphuretted hydrogen is not free from sulphur, but retains, chiefly in combination with carbon, a quantity of this element, varying from ten to forty grains in 100 cubic feet. It is commonly believed that the small quantities of sulphurous and sulphuric acid produced by the burning of coal gas distinguish it unfavorably from other illuminants, and hence there is a general wish among both the consumers and producers of gas to remove as far as possible the last traces of sulphur.

Sulphuretted hydrogen is one of the few substances for whose presence, even in very small quantity, we have a test which anyone can apply, which is quick and conclusive. The existence of such a test has no doubt contributed greatly to the development of a system of purification, by which coal-gas, at least in London, is always and absolutely freed from sulphuretted hydrogen. In his endeavor to purify gas from other sulphur compounds the manufacturer has no test so handy as the strip of lead-paper, to bear witness at once when the purifying material needs renewal. Increased facility of testing might lead, in this case also, to the discovery of better methods of purification or to a better management of existing methods.

While endeavoring to turn to account for the purification of gas the effect of heat upon it, which converts the bi-sulphide of carbon in gas into sulphuretted hydrogen, it occurred to me that a test might be based on the same principle.

I have here a glass tube filled for two inches with a plug of platinum wire and foil. I am passing gas through it, but as the gas is pure from sulphuretted hydrogen it does not affect the paper moistened with solution of acetate of lead upon which the gas is blowing. Now I heat the tube, and you will soon have evidence of the presence of sulphur in the gas.

This, however, is only a qualitative test, or at most the rate at which the paper darkens furnishes a very rough indication of the amount of sulphur in the gas. In the case of an impurity such as sulphuretted hydrogen, which is to be wholly removed, a qualitative test of this kind is all that is required. But, as no means are known of arresting completely the other compounds of sulphur, and all that can be done is to reduce their proportion as low as possible, a qualitative test is insufficient. What is required, as a guide in managing the process of purification, is a rapid quantitative test.

To fulfil this requirement, I propose to substitute, for the lead-paper with the gas blowing upon it, a solution of lead, through which the gas shall pass in small bubbles. All the sulphuretted hydrogen in the portion of gas operated on is thus arrested; and, through the mixing of the liquid, an uniform color is obtained, whose shade the eye can compare with that of a similar portion of a standard colored liquid. If the passage of the gas is continued until the tint, which grows continually darker, matches that of the standard liquid, a definite and ascertainable quantity of lead sulphide must have been formed, containing a known quantity of sulphur, and that derived from a known volume of gas. The larger the volume of gas that must be passed before this tint is attained, the smaller, in exact inverse ratio, is the proportion of bi-sulphide of carbon in the gas.

To prepare a lead solution which gives a clear tint instead of becoming turbid when acted on by sulphuretted hydrogen, I dissolve litharge in caustic soda, and add a relatively large quantity of solution of sugar. Nor each testing, a little of the solution thus prepared is mixed with twenty or thirty times its volume of water.

For a standard of comparison, I have tried various coloring matters. Any red, yellow, and blue seem to give a brown. Cochineal, caramel, and indigo rightly proportioned, matchod the tint of the colored lead solution very satisfactorily; and the appearance of the liquid did not change perceptibly from day to day; but, after some weeks, I found that my result had varied, and that the gradual fading of the standard color was the cause. Since then I have used a mixture of the three sulphates of copper. cobalt and iron, substances which are perfectly stable. To imitate a dark shade which the colored lead solution has, probably owing to the sulphide of lead not being really dissolved, but rather suspended in a state of minute division, I add a trace of lampblack to the standard liquid.

Unfortunately, the colored lead solution and the standard look differently by daylight and by gaslight, and, through the change of light, they become extremely different one from another. I have, therefore prepared another standard for use by gaslight, and it happens conveniently that a mixture of the sulphate of cobalt and copper serves the purpose.

The volume of gas which has been operated upon is known with sufficient accuracy by reading off the volume of water which has run from the aspirator into the measuring vessel placed beneath. The standard has been made such, that to impart the same tint to the same volume of lead solution, there is required 0.0025 grain of sulphur. From this datum, and the capacity of the measuring cylinder, I have calculated a table giving the number of grains of sulphur in one hundred feet of gas corresponding to each graduation.

The apparatus in the form in which I have it here is probably familiar to some who are present, as I brought it before the meeting of the British Association of Gas Managers at Leeds last summer, and my account of it was published in the *Journal of Gas-Lighting*. But quite recently a suggestion made to me by Mr. Wills has led to an improvement in the apparatus, which may, I hope, help to justify me in giving this further account of it.

Mr. Wills suggested to me to use platinum as the heated material over which the gas should pass, he having observed that the development of sulphuretted hydrogen occurred at a lower temperature when the gas was in contact with platinum, than when it heated otherwise.

Such an action of platinum upon mixtures of gases is familiar to chemists by many examples, and I can only plead in defence of the comparatively bulky and inconvenient form which my test has assumed hitherto, that I designed it, in the first place, not for laboratory use, but to illustrate a chemical fact, which I hoped to turn to account on a large scale for the purification of gas. Those who have used it must, I think, have convinced themselves that when gas is passed through a layer of heated pebbles, the sulphur contained in it, with the exception of 8 or 9 grains in 100 cubic feet, is converted into sulphuretted hydrogen, and can, therefore, be easily removed.

If any others have had this test in operation, as I have, continuously for several months, they will also have convinced themselves that the action of the heated surface upon the gas may be continued for an indefinite time, if the temperature is not allowed to rise too high, and if, at intervals of one or two months, air is drawn through the apparatus.

Experimenting with this larger object in view, I made trial only of common materials which it was practicable to use on a large scale. Perhaps it is impossible that so costly a metal as platinum should be used in gas manufacture, especially where the object in view is only a slight improvement in the quality of the article manufactured. But it is possible to employ costly materials for common use where, as in the use of gold on paper-hangings, little goes a long way. Substances which can be dissolved, may be spread over an indefinitely large surface, by wetting the surface with their solution. Mr. Deacon has thus applied copper to the manufacture of chlorine. Whether or not the action of heated platinum on gas may hereafter find any more extended application, it serves exceedingly well the purpose of this test. It may be used by leading gas through either a piece of glass tube packed with platinum wire, ar a bulb filled with pumice which has been steeped in chloride of platinum and ignited.

I have now in the second place to direct your attention to certain methods of estimating the illuminating power of coal gas. Such methods divide themselves into two kinds; those in which the amount of light obtainable from a given volume of gas is, by some means, directly estimated, and those in which it is inferred from some other property of the gas.

Of the latter, which I may call indirect methods, one of the best, but the most troublesome, is the complete analysis of the gas. This demands a special and somewhat complicated and fragile apparatus, and considerable manipulative skill on the part of the operator. Improvements in the methods of gas analysis have considerably reduced the length of the operation, but it can hardly occupy less than three or four hours.

Some information, but of rather uncertain value, is to be derived from the determination of the specific gravity of the sample of gas.

Absorption by bromine of the olefines, to which chiefly the illuminating power of gas is due, is an operation which can be easily and quickly performed, and which should give trustworthy, though not very exact, indications of the relative value of different samples of coal gas.

The simplest and most trustworthy of the indirect methods are those which depend upon the relation between the quality of different samples of gas burning under the same conditions, and the size of the flame which they produce. The size of the flame is most easily observed by giving it the form of a long, narrow column as in Lowe's jet photometer. The samples of gas to be compared may be burnt when issuing either at the same pressure, or at the same rate. Or else the length of flame may be kept constant and the required pressures or rates of consumption compared. The last-named modes of operation are those employed in Messrs. Kirkham and Sugg's form of the jet photometer, and in the "duration" test. Still another mode of making the same comparison has recently been proposed by Mr. Sugg, who

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has been kind enough to lend me his illuminating power meter to show here this evening. In this instrument the gas is set to burn from an Argand burner with a flame three inches in height. It can be made either to pass through the meter or not; and in the upper part of the meter case is a minute clock. The index of the meter having been stopped at the top of the scale, gas is sent through the meter for one minute by the clock, and then turned off again, the flame being constantly maintained at the height of three inches. According as the gas is richer or poorer, the index of the meter will have travelled a less or greater distance; and the dial-plate is so graduated and numbered, that from the place at which the index has stopped, the illuminating power of the gas may be read off.

[To be continued.]

Rainfall on the Basin of the Schuylkill River.

By HENRY P. M. BIRKINBINE.

The following abstract from notes made during the years 1867 to 1870, when the writer was Chief Engineer of the Water Department of the city of Philadelphia, is presented with some hesitancy, because of its incompleteness as a full consideration of the subject. At the time of change in the office of engineer, an extensive set of observations was in progress, or on the point of institution, which, after completion, would have permitted a thorough exhibition of the physical character of the district from which the water of Philadelphia is derived; as it is, however, the subjoined notes may possess some value for the purposes of estimate.

The Schuylkill River has its rise in the Blue Mountains, and flows about southeast, draining a diversified country, about one-half of which is mountainous or hilly, and all of it undulating.

Drainage Area.—The water shed above Fairmount dam includes an area of one thousand nine hundred and forty-two (1942) square miles, and occupies parts of eight (8) counties, as follows:

Philadelphia	County.....	22 sq miles.
Montgomery	"	396 "
Bucks	"	82 "
Chester	"	161 "
Berks	"	841 "
Lehigh	"	73 "
Lebanon	"	43 "
Schuylkill	"	324 "
Total.....		1942 "

Average and Available Rainfall.—The average annual rainfall upon this area is forty-five (45) inches; of this amount about 40 per cent. (eighteen inches) reaches the Fairmount dam, the remainder being lost by evaporation and absorption. The average rainfall was determined by a careful tabulation of monthly reports of observations made at various points in the Schuylkill valley; these reports extended in two instances, viz.: Philadelphia and Lebanon, over a period of forty years. The following data formed the basis upon which the estimate of 18 inches available precipitation was made.

Boston.—The average rainfall collected from the area drained from Lake Cochituate, from which Boston is supplied, is forty-six per cent. of the precipitation, vide: "History of the introduction of pure water into the city of Boston." Boston, 1868, table No. 2, page 275.

Brooklyn.—The ponds from which Brooklyn is supplied collect fifty per cent. of the total rainfall upon their drainage areas, vide: "Brooklyn water works and sewer." New York, 1867, page 65.

Mississippi River.—In the "Report upon the physics and hydraulics of the Mississippi," by Humphreys and Abbot, Philadelphia, 1861, page 136. The available percentage of the rainfall upon the drainage area is given as follows:

Small tributaries.....	90 per cent.
Ohio River.....	24 "
Upper Mississippi River.....	24 "
Missouri River.....	15 "
Entire Mississippi, exclusive of Red River.....	25 "

Croton River.—The minimum flow of the Croton River, by measurement, is 0·3 cubic feet per second, for every one thousand acres; or 124,416 gallons per day per square mile, vide: "Brooklyn water works and sewers." New York, 1867, pages 63 and 64.

Evaporation.—During the summer months the evaporation averages 0·115 inches per day from the surface of the water, vide: "Twentieth annual report of the Croton Aqueduct Department." New York, 1868, Doc. 2, page 10.

Daily Flow of Schuylkill.—The average annual rainfall may therefore be assumed at 45 inches, of which 18 inches is discharged into the Fairmount Pool; this will give a daily flow of 1,664,369,413 gallons.

Freshets.—In times of freshets, a very large amount of water wastes over the dam; this will probably reach an average throughout the year of 1,000,000,000 gallons per day.

Ordinary Flow of Schuylkill.—The daily average flow of the stream at its ordinary stages is therefore about 650,000,000 gallons, which would give a head of five and one-half inches above the comb of Fairmount Dam.

20-*Inch Freshet.*—A freshet of twenty inches on the dam will waste over four billions of gallons per day.

25-*Inch Freshet.*—The head of water on the dam May 3d, 1869, was twenty-five inches; this is equivalent to a daily flow of 6,600,600,000 gallons. And on September 27, 1869, there was a head of *thirty-six* inches on the dam, which is equivalent to a daily flow of 13,600,000,000 gallons.

Formula.—These calculations are based upon the formula $Q=3{\cdot}01208lh^{1{\cdot}53}$, when Q=cubic feet per second. This formula is given by Jas. B. Francis, C.E., and is the result of experiments made at Lawrence, Mass., on a dam having an overfall 900 hundred feet long, erected across the Merrimac River by the Essex Water Company, vide: "Lowell Hydraulic Experiments." Boston, 1865, and New York, 1868, page 136.

Effects of Forests.—The annual amount of water flowing in a river is about the same for each year, but by cutting off the forests and cultivating the land, storm water flows off more rapidly and the amount of spring water is lessened, thereby augmenting the maximum and decreasing the minimum discharge of the stream, and causing the maximum and minimum flow to be more frequent and farther removed from the mean, vide: "Man and Nature," by Geo. P. Marsh, New York, 1864.

Noticed on the Schuylkill.—The effects of forests upon springs and streams of water has been frequently observed in the cutting off and the growth of chestnut trees, on the Schuylkill drainage.

Minimum Flow.—The minimum flow of the Schuylkill is frequently less than two hundred million gallons per day; as shown by the amount of water which is available for pumping in dry seasons.

Calculation of Flow.—Taking as a basis of calculation the minimum flow of the Croton River, 0·3 cubic feet per one thousand acres; would give a discharge from the Schuylkill drainage of 241,615,872 gallons per day; from this must be deducted the evaporation in the summer months, viz.: 0·115 inches. Assuming the superficial area of the river, dams, pools, etc, to be 20 square miles; this amount will be 39,971,339 gallons—giving as the minimum flow 201,644,534 gallons per day.

Store Reservoirs.—During seasons of drought it was found not possible to maintain navigation by the natural flow of the river; it therefore became necessary to construct impounding reservoirs near the head waters.

Tumbling Run No. 1.—The first of these was completed upon Tumbling Run in 1834, vide: "Annual Report of the Schuylkill Navigation Company for 1834," page 6.

Tumbling Run No. 2.—A second was completed in 1837 upon the same stream, and both raised in 1840, to increase their capacity, vide: "Annual Report of the Schuylkill Navigation Company for 1840, page 9."

Silver Creek.—A third was constructed about 1854 upon Silver Creek.

Sizes and Capacities.—The sizes and capacities of these reservoirs are as follows:

	Depth of water in ft. and inches.	Area of water in acres.	Contents in gallons.
Tumblg. Run No 1..	53′ 8″	25·57	191,598,900
" " " 2..	57′	31·45	298,924,590
Silver Creek Reservoir.....	37′	42·	320,853,750
Total Capacity.			811,377,240

Navigation Interrupted.—When any one of these reservoirs was out of order, navigation of the river has been interrupted.

Reservoirs Insufficient.—The total capacity of these reservoirs, 811,377,240 gallons, is not sufficient to keep up the mean flow of the river at Fairmount for two days.

River below Reading.—The river below reading is broader, the fall of the water is less rapid, the dams cover a larger surface, and the evaporation is greater. The amount of water necessary to keep up the navigation upon this part of the stream will therefore be much in excess of the quantity required for the same purpose above Reading.

Average Summer Rainfall.

Philadelphia	for 40 years.....	12·5	inches.
"	" 18 "	12·416	"
Lebanon*	" 40 "	11·79	
Norristown	" 9 "	12·30	"
Av'ge on Schuylkill drainage.		12·251	"

Observations of Declivity of the River.—Efforts have been made to determine the fall or declivity of the river, produced by the flow of a given amount of water. A number simultaneous observations were made at five points, viz: Fairmount dam, under Columbia Bridge, under City Bridge at Falls, at Pencoyd Iron Works, and at Manayunk Locks.

Constant Variations of Declivity.—These observations demonstrate a constant variation, caused by starting and stopping the wheels at Fairmount water works, or at various factories, the lockage of boats, the direction and intensity of the wind, etc.

Calculation Impossible.—The declivity cannot be determined by calculation, as there are no formulæ which meet the conditions of the river varying so much in width, with so many bends, and with a bed obstructed by rocks, shoals, coffer-dams, bridge piers, etc.

Measurements made August 31st, 1870.—The nearest approach to determining the correct declivity was

made August 31st, 1870, when the estimated daily flow was 585,000,000 gallons; the surface of the water under Columbia Bridge was two and three-quarter inches. The surface of the water under the City Bridge at Falls, three and a-half inches. The surface of the water opposite Pencoyd Iron Works, five inches, and the surface of the water at Manayunk, six inches. These heights are above the level of the water on Fairmount dam, and represent the approximate declivity of the river at its ordinary stage.

Practically no Declivity during Minimum Flow.—The quantity of water flowing in the stream materially influences the fall. When the mills and navigation are stopped, and the flow of the water is reduced to that which leaks through the locks, dams and wickets, there is practically no declivity in the stream.

Declivity during Freshet, October 4th, 1869.—The greatest recorded freshet in the Schuylkill occurred October 4th, 1869, when there was 11·46 feet of water on the Fairmount dam. The declivity of the surface of the water was over 20 feet in six and two-third miles. The fall was not uniform, but consisted of a series of inclines, and varied from less than half a foot to nearly 10 feet per mile, vide: "Second Annual Report of the Commissioners of Fairmount Park," Philadelphia, 1870, pp. 39 and 40.—*Jour. Franklin Inst.*

To Purify Glass Vessels.—All kinds of glass vessels and other utensils may be purified from long retained smells of every kind, in the easiest and most perfect manner, by rinsing them out well with char coal powder, after the grosser impurities have been scoured off with sand and potash. Rubbing the teeth with fine charcoal powder, and then washing out the mouth, will render the teeth beautifully white and the breath perfectly sweet, where an offensive breath has been owing to a scorbutic disposition of the gums. Putrid water is immediately deprived of its bad smell by charcoal. When meat, fish, etc., from intense heat or long keeping, are likely to pass into a state of corruption, a simple and easy mode of keeping sound and healthful is to put a few pieces of charcoal, about the size of an egg, into the pot or saucepan wherein the fish or flesh is to be boiled.

Price of Gas.

In reply to our request in the last number of the Journal, we have received quite a number of answers We hope that all those who have not yet sent us the price at which they sell gas, will not fail to do so at as early a day as possible. It is proposed to continue the list so as to make the record complete.

The following prices are *official*, having been furnished to the American Gas-Light Journal by the officers of the various Gas Companies.

Albany (Peoples) N. Y.	$2.75	
Annapolis, Md.	3.40	
Atchison, Kansas.	4.50	
Austin, Texas.	6.00	
Allegheny City, Pa.	1.80	20 p. ct. off prompt pay
Albany, N. Y.	2.75	
Ashland, Ohio.	3.50	Street lamps 4½ hours 17 nights per month, $15 per annum.
Augusta, Ga.	4.00	Net.
Anderson, Ind.	3.50	Crude petroleum.
Ashtabula, Ohio.	2.00	Wren's process; $10 for 80 candle gas.
Auburn, N Y.	3.50	5 p c off prompt pay.
Brooklyn, B'klyn.	2.75	
" Citizens.	2.75	
" Nassau.	2.75	
" Metropol'an	2.75	
" Peoples.	2.75	
" W'msburgh	2.75	
Brockton, Mass.	3.80	
Batavia, N. Y.	3.00	
Bridgton, N. J.	3.50	
Bangor, Me.	3.00	
Boonville, Mo.	4.50	
Brownsville, Tenn.	4.50	
Belfast, Maine.	4.00	10 p. c. off bills over $10; 5 p. c. off bills under $10.
Brockville, Ontario.	3.75	
Bloomfield, N. J.	3.75	
Belleville, Ill.	3.50	
Bellaire, Ohio.	2.85	5 p ct. off prompt pay.
Barnesville, Ohio.	3.00	5 p ct. off prompt pay. Street lamps $17.50 per ann. Burn till 12 P. M. on moonless nights.
Boston, Mass.	2.25	
Bath, Maine.	4.00	12½ p c off prompt pay.
Bayonne City, N. J.	4.00	Net.
Binghampton, N. Y.	4.00	10 p c off prompt pay on bills for 1000 per month.
Buffalo G L Co., N Y.	2.50	10 p c off prompt pay.
Buffalo Mutual, N Y.	2.50	10 p c off prompt pay.
Buffalo Citizens, N Y.	2.50	10 p c off prompt pay.
Cleveland, Peoples, O	2.00	
Cumberland, Md.	3.00	
Charleston, W. Va.	4.00	25 p. ct. off prompt pay Meter rent 25, 30, and 50 cents. per m. for 3, 5 and 10 light.
Cincinnati, Ohio.	2.25	
Columbia, Mo.	4.50	
Carondolet, South St. Louis, Mo.	3.00	5 p. ct. off prompt pay,
Chattanooga, Tenn.	3.00	
Cold Water, Mich.	3.25	
Chicago, Ill.	2.50	
Columbia, Pa.	2.85	Lowe process.
Charlottesville, Va.	3.50	Meter rent 20 cents.
Cedar Rapids, Iowa.	4.50	50 cts p M. off prompt pay.
Cairo, Ill.	3.75	50 cts added if not paid by the 5th.
Cortland, N. Y.	4.00	25 cts p M. off prompt pay.
Cairo, Ill.	3.75	50 cents per month off prompt pay. For 20,000 feet a month $2.50.
Chillicothe, Ohio.	3.00	
Derby, Conn.	3.60	10 p. c. off prompt pay, and 50 cts per M. on excess of 5000 ft. per month.
Decatur, Ill.	3.50	50 cts. per M. added, if not paid by 10th.
Danbury, Conn.	4.28	For less than 5000 per month.
" "	3.85	For over 5000 per m th
Dover, Del.	3.60	
Dunkirk, N Y.	2.50	Street lamps till 12, moonless nights $25 per annum.
East Boston, Mass.	3.00	
East St. Louis, Ill.	3.50	5 p. c. off prompt pay.
Evansville, Ind.	3.00	City lamps $30.
Erie, Pa.	3.00	City lamps $28 p. an.
Elkhart, Ind.	3.50	
East Newark, N. J.	4 00	
Eastchester, N. Y.	3.50	
Elizabethtown, N. J.	3.00	
East N Y (Union) L I	3.00	
Fredericksburg, Va.	3.40	
Flint, Mich.	3.50	
Franklin, Pa.	3.00	
Fall River, Mass.	3.00	
Freeport, Ill.	3.80	
Fort Scott, Kansas.	4.50	
Guelph, Ontario.	3,50	
Geneva, N, Y.	2.50	5 p. c. off prompt pay. Wood and oil gas.
Greensboro, N. C.	4.00	
Galena, Ill.	4.50	Meter rent 25 cts. per month.
" "	4.00	After September 1st.
Grand Rapiids, Mch.	2.80	For less than 1000 feet per month.
" " "	2.50	For over 1000 feet per month. 10 per ct discount on 300,000 ft annually.
Gloucester, N. J.	3.15	5 p c off prompt pay.
Greenwich, Conn.	2.40	Wren's process
Huntsville, Ala.	3.50	
Hempstead, L. I.	4.00	
Huntingdon, Pa.	3.80	10 per ct. off prompt pay.
Hagerstown, Md.	3.75	
Hamilton, Ohio.	4.00	
Hillsdale, Mich.	3.50	
Holyoke, Mass.	3.01	
Hornellsville, N. Y.	3.50	50 cents per 1000 off prompt pay.
Honesdale, Pa.	4.00	12½ cents meter rent per month.
Ithaca, N. Y.	4.00	5 p. c. off prompt pay.
Indianapolis, Ind.	2.50	
Indiana, Pa.	3.00	10 p. c. off prom pay. Meter rent 50 cents per month.
Jersey City, N. J.	2.75	
Joliet, Ill.	3.50	
Jacksonville, Ill.	4.00	12½ p.c. off prompt pay.
Jefferson City, New Orleans, La.	4.00	
Johnstown, N Y.	3.50	
Knoxville, Tenn.	3.00	Meter rent 15 cents.
Lyons, N. Y.	4.00	
Lima, Ohio.	3.80	
Lynchburgh, Va.	3.00	5 p. ct. added to bills not paid in 5 days.
Louisiana, Mo.	4.50	
La Crosse, Wis.	4.50	50 cents per M. off prompt pay.
Lancaster, Pa.	3.00	
Louisville, Ky.	2.70	5 p. c. off prompt pay.
La Porte, Ind.	3.50	Wood and oil gas.
Lowell, Mass.	2.50	25 cents per 1000 off prompt pay.
Lafayette, Ind.	2.75	
Lexington, Mass.	2-40	Wren's process.
Millville, N. J.	3.12	
Milford, Del.	3-50	
Marquette, Mich.	3.50	
Morris, Ill.	2.00	For 15 candle power, or $10 per M. coal gas meter measure (Petroleum Gas—Wren's patent).
Meriden, Conn.	3.93	
Marietta, Ohio.	3.50	20 cts. per M. off if paid by 6th. Consumers over 3000 ft. 30 cts. additional discount.
Marshalltown, Iowa.	4.50	50 cts p M. off prompt pay.
Meadville, Pa.	3.50	25 cts p M. off prompt pay.
" "	2.50	For over 10,000 ft. per month,
Monroe, Mich.	3.50	5 per ct off prompt pay
Malone, N. Y.	4.50	
Middletown, Conn.	3.56	Net.
Madison, Ind.	3.75	25 p c off if paid in five days: 25 to 40 cents per month meter rent.
Mount Sterling, Ky.	4.50	
Monongahela, Pa.	2.75	Under 5000 feet m'th $2.75 per M.; over 5000 feet per month $2.50 per M.
New York, New York.	2.50	
" " Harlem.	2.75	
" " Manhattan	2.50	
" " Mutual.	2.50	
" " Mropolitan	2.50	
" " Municipal.	2.50	Water Gas.
Nashville, Tenn.	2.85	
Newark, Citizens, N.J	3.00	5 p. c. off prompt pay.
Norfolk, Va.	3.10	
New Brunswick, N. J.	2.70	
Newton, N. J.	4.00	
North Attleboro, Mass.	3.50	
New Britain, Conn.	3.70	
New Haven, Conn.	2.75	
Nantucket, Mass.	3.00	Meter rent 15 cts. p. m.
Newark, N. J.	2.85	
Niagara Falls, N. Y.	3.50	20 cts p M. off prompt pay.
Norwalk, Conn.	4.00	12½ p ct off prompt pay.
New Albany, Ind.	3.00	
Oswego, N. Y.	3.15	5 p. c. off prompt pay.
Ottawa, Ill.	4.00	12½ p. c. off promptpay
P'keepsie, Citizens.	2.70	Gwynne Harris process
Paterson, N. J.	3.80	10 p c. off prompt pay, and in addition 5 p.c. on bills of $200; 10 p. c. on bills of $100
Portchester, N. Y.	3.50	
Pittsfield, Mass.	3.50	5 p. c. off prompt pay, and 10 p. c. off on bills of $350 per an.
Portland, Me.	3.00	
Paris, Ky.	4.50	Meter rent 25 cts. p m.
Portsmouth, N. H.	3.22	
Pittsburgh, Pa.	1.00	
Philadelphia, Pa.	2.15	
Painesville, Ohio.	3.50	
Pawtucket, R. I.	3.00	Over a million feet a year $2.70.
Providence, R. I.	2.25	
Pottsville, Pa.	3.50	10 p ct off prompt pay.
Plainfield, N. J.	3.50	5 p ct off for less than 5000 a month. 10 per cent more than 5000 a month.
Peoria, Ill.	3.50	
Paducah, Ky.	4.00	10 p c off prompt pay.

* Lebanon is situated on the water-shed dividing the drainage of the Schuylkill and Susquehanna, 86 miles from Philadelphia and 456 feet above tide.

Pottstown, Pa	3.20	Public lamps till 11 P. M., 18 nights per month $20 per lamp.
Poughkeepsie, N Y	2.60	10 p c off prompt pay.
Quincy, Citizens, Mass.	5.00	
Quincy, Ill	3.50	
Quebec, Ont	2.40	
Rome, N. Y.	3.60	
Rochester, N. Y	3.00	
" Citizens	3.00	
Rondout, N. Y.	3.60	
Rockford, Ill.	4.00	5 p c off prompt pay; 10 to 25 p c off on bills for 500 to 25 M, feet per month.
Syracuse, N. Y.	2.75	
Springfield, Ill.	3.25	$25 for city lamps.
St. Joseph, Mo.	4.00	12½ p. ct. off on bills over $100 p. month.
St. Albans, Vt.	5.00	10 p. c. off prompt pay, and in addition 5 p. c. off bills from $50 to $100 per month; 10 per. ct. off bills over $100.
Sandusky, Ohio.	3.00	
Saratoga, N. Y.	5.00	20 p. c. off prompt pay, Nov. 1st to May 1st. 10 p. c. rest of year.
San Antonio, Texas	7.00	10 per ct off from 10 to 20,000 per month 20 p ct off from 20,000 and upwards.
St. Charles, Mo.	4.50	
Sidney, Ohio	3.25	
Steubenville, Ohio	2.50	
Sherman, Texas	5.00	5, 10, 15 and 20 p. c. off, according to quantity.
Salem, Oregon	7.00	October last reduced from $8.
Salem, Ohio	2.75	Meter rent 12½ cts if 300 feet is not used monthly
Sedalia, Mo.	3.50	
Sharon, Pa.	3.15	5 per ct off on less than 5000 feet per month. 10 p ct from 5 to 15 M. 15 p ct from 15 to 20 M. 20 per ct over 40 M.
Shreveport, La.	5.00	
Shelbyville, Ind.	2.00	Wren's process; $10 for 80 candle gas.
Tiffin, Ohio.	3.00	
Titusville, Pa.	3.00	
Tidioute, Pa.	2.00	Wren's process.
Vicksburgh, Miss.	4.50	
Wilkesbarre, Pa.	3 50	10 p. c. off prompt pay.
Worcester, Mass.	3.00	5 p. c. off on $500, and 10 p. c. off on $1000 in six months.
Westfield, N. Y.	4.00	10 p. c. off prompt pay.
Washington, D. C.	2.25	
Watertown, N. Y.	4.50	10 p. c. off prompt pay.
Wheeling, West Va.	2.25	10 p ct off prompt pay.
Washington, Pa.	2.50	
Woburn, Mass.	3.00	
Waterbury, Conn.	3.50	5 p c off on biils of $50 10 p c off on bills of $100. 5 p c added if not paid by 10th.
York, Pa.	3.00	Meter rent 12½ cents.
Youngstown, Ohio	2.50	10 p. c. off on bills of $50 per month.
Waterbury, Conn	3.00	5 p c off on bills of $50, 10 p c off on bills of $100; 10 p c added if not paid by 10th.
Washington, C H., O.	1.20	Wren's process; $6 for 80 candle gas.
Wilmington, Del.	2.50	Street lamps 3,650 hrs per year, $31.50 per lamp.
Zanesville, Ohio.	2.70	10 p. c. off on bills of $25 per month; city lamps $23.

Gas Stocks.

Quotations by W. R. Scott & Co., Bankers,

24 Pine Street, New York City.

May 16, 1876.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.

	Capital.	Par.	Bid.	Asked
Harlem	$1,850,000	50	115	120
Manhattan	4,000,000	50	255	260
Metropolitan	2,500,000	100	145	150
" Scrip	$1,000,000	..	102	—
" Bonds	500,000	1000	104	—
Mutual	5,000,000	100	108	109
" Bonds, gold.	900,000	1000	105	—
New York	4,000,000	100	135	140
Central, Westchester	466,000	50	100	105
Gas Co.'s of Brooklyn.				
Brooklyn	2,000,000	25	190	195
Citizens	1,200,000	20	90	100
" Scrip	320,000	1000	95	100
Peoples	1,000,000	10	60	65
" Bonds	$ 325,000	...	—	95
" Scrip	300,000	...	85	—
Metropolitan	1,000,000	100	—	75
Nassau	1,000,000	25	90	95
" Ctfs.	700,000	1000	96	98
Williamsburgh	1,000,000	50	120	125
" Scrip		...	96	100
Out of Town Gas Companies.				
Buffalo Mutual, N. Y	750,000	100	—	80
" Bonds	200,000	1000	—	90
Baltimore, Md.	2,000,000	100	178	186
" Ctfs., gold	1,000,000		105	—
Brockport, N. Y.	25,000	100	...	80
Citizens, Newark	918,000	50	87½	—
" " Ctfs.	53,000	—	—	—
" " Bds.	124,000	—	—	—
Derby of Conn.	160,000	100	60	80
East Boston, Mass.		25	132	—
Hannibal, Mo.	100,000	100	95	100
Hartford, Conn.	700,000	25	41	—
Hempstead, L	25,000	100	...	—
Jersey City	386,000	20	160	170
Jamaica, L. I.	25,000	100	...	—
Jacksonville, Ill.	120,000	50	82	...
Lewistown, Maine	400,000	100	50	85
Lima, Ohio	60,000	100	85	...
" Bonds	30,000			
Laclede, Mo.	1,200,000	100	---	115
Peoples, Jersey City		...	125	135
Peoples of Albany	650,000	100	—	40
" Bonds	350,000	1000	—	—
Peoples of Baltimore		25	101	102
" Bonds			106	—
Rochester, N. Y.		100	50	60
Richmond Co., S. I.	300,000	...	100	105
Fort Wayne, Ind.		100	...	—
Woonsocket, R. I.	150,000	100	100	...
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150,000	40	112½	
San Francisco Gas-Co., S. Fr'isco Cal.			99	100
St. Louis, Missouri	600,000	50	110	130
Stillwater, Minn.	50,000	50	—	26
Suburban, W'stch'str	390,000	50	—	100
Troy, Citizens	600,000	100	—	100

PRICES OF FOREIGN AND DOMESTIC GAS COALS.

(Reported Expressly for this Journal.)

May 16, 1876.

DELIVERED IN NEW YORK.

English Cannel.

Ince Hall	$17 00	@	18 00
Kirkless Hall	16 50	@	17 00

English Caking Coals.

Newcastle Gas	$5 50	@	00 00
Liverpool caking	11 50	@	12 00

British Province Coals.

Pictou			2 00
Block House—At Mines, $1.87, Gold			2 00
Caledonia—At Mines, $1.50, Gold			0 00
Little Glace Bay—At Mines, $1.75, Gold			0 00
Lingan—At Mines, $1.75. Gold			0 00
Sydney—Old Mine			3 00
" Reserve, $1.75, GoldMine			0 00
" International			— —

Duty, 75 cents per ton, gold. Freight to New York $2 00 currency. Cost of above coals delivered in New York, $4 75 @ $5 00, currency.)

Pennsylvania Coals.

Penn Gas Coal—At Amboy	$5 60	@	0 00
Westmoreland—At Amboy	5 60	@	0 00
Shafton	5 60	@	0 00
(In New York, the above coals $6 00)			
Youghiogheny	6 00	@	0 00
Waverly	6 00	@	0 00

West Virginia Coals.

Murphy Run	6 50	@	0 00
Despard	6 50	@	0 00
West Fairmont	6 50	@	0 00
American Gas Coal	7 40	@	0 00
Fairmont	6 50	@	0 00
Newburgh Orrel	6 50	@	0 00
Pinnickinick	6 50	@	0 00
Cloverhill of Virginia	6 00	@	6 50
McKenzie Compound Mixture			— —

American Cannel Coals.

Peytona of West Virginia	$12 50	@	00 00
Darlington of Pennsylvania			— —
Cannelton Cannel			11 00
Red Bank—at Philadelphia			6 50
" —at South Amboy			7 25

Asphalts.

Albertite of New Brunswick	$21 00	@	— 00
Trinidad Bitumen	— —	@	14 00

The Penn Gas Coal Company have contracted with the Pittsburgh Gas-Light Co. for their entire supply for the ensuing year from their Youghiogheny mines.

Within the last week contracts have been made by some of the companies in New York for about 200,000 tons of Penn Westmoreland, Waverly, Youghiogheny, and the West Virginia caking coals—at $6 00 per ton a reduction of 50 cents from last years' prices.

TO GAS COMPANIES, AND CITY GOVERNMENTS.

DYOTT'S PATENT CHAMPION STREET LAMP

Doubles the Light with the same quantity of Gas used in other Lanterns. *All others* waste half their light, illuminating the sky, or if the top s of metal, absorb it.

Single Top Glass Lamps both Globular and Square become heated if a good light is put in them, and rain, hail or snow falling upon the heated glass breaks it. When one glass is broken the wind will either blow the flame against the others and break them, or destroy the entire Lamp. *Nine-tenths of the breakage and cost of repairs of other* street lamps is owing to that cause.

Dyott's "Champion" is the only double top—the only Lamp that has the Opaline White Dome, which is a *never changing reflector;* it doubles the power of, and throws the light to a greater distance. It is also a perfect *protector,* shielding the heated top or the lamp from all inclemency of the weather. The white dome is kept cool they passage of air between it and the transparent globe below. Rain, hail or snow will never break either the globe or dome. The globe rests upon rubber cushions, and is supported laterally by elastic springs, so that contraction or expansion of the globe, or jarring of the post will not break it. They can be cleaned in one-fourth the time required to clean other lanterns. The metallic portions are of iron, copper and brass, and are the most durable, economical, efficient and cheapest lamps in existence. For public buildings, and wherever an ornamental and powerful light is required, they are made in clusters of 2, 3, 4, 6, 7 and 10 lamps, which have no equal in this or any other country for *beauty, durability, efficiency* and economy, either in cost, use or ornamentation. Designs furnished when requested for specific purposes. Gas companies, or those who have the lighting of Cities in charge, are solicited to communicate with us in reference to the agency for its introduction.

The Franklin Institute has awarded our Champion Lamp the highest premium: (they give a silver medal) and its Committee on Science and the Arts has recommended it as the best lamp in use. It has also invariably taken the highest premium at every Exhibition at which it has been presented, and elicits the strongest commendations wherever it is used. We have several new and handsome patterns of Posts for Corporations, Parks, public and private use, also for clusters of lamps, that are not excelled in beauty or price at which they are furnished

DYOTT MANUFACTURING CO.,
114 South 2nd Street, Phil'a, Pa.

374-6meot

H. R. SMITH & CO.,

COLUMBUS, OHIO,

MANUFACTURERS OF

CAST IRON GAS & WATER PIPE BRANCH CASTINGS, LAMP POSTS, ETC.

(Pipe from three inch and upwards cast *vertically* in 12 feet lengths.)

RAILROAD CROSSINGS, FROGS, SWITCH STANDS,

AND ALL KINDS OF

RAILROAD, ROLLING MILL- BLAST FURNACE, ARCHITECTURAL AND MACHINERY CASTINGS.

DAILY CAPACITY 125 TONS.

☞ Our Works *connect direct* with *eleven railroads* centering in this city, giving us unequalled facilities for shipping to all points, at the lowest rates of freight. 405-1y

Brooklyn Clay Retort AND FIRE-BRICK WORKS,

VAN DYKE STREET, BROOKLYN, N. Y.

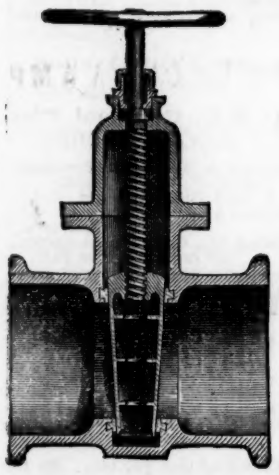
EDWARD D. WHITE, Surviving Partner of the late firm J. K BRICK & CO. 402-1y

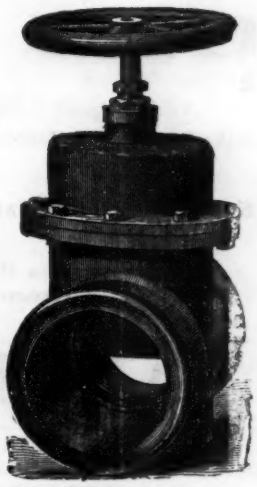
CHAPMAN VALVE MANUFACTURING CO.

MANUFACTURERS OF

CHAPMAN GAS VALVES.

Office and Sales Room 75 and 77 Kilby Street, Boston.





These Valves have been in use for several years, and are pronounced by all who have used them to be

The Best Gas Valves Ever Made.

They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves. It does not corrode under any circumstances to which it is exposed.

There is no LIABILITY OF COHESION between the Gate and Seat, and the Valves can be relied upon to SHUT TIGHT and OPEN EASILY at all times—an important desideratum when used for street mains, in cases of fire.

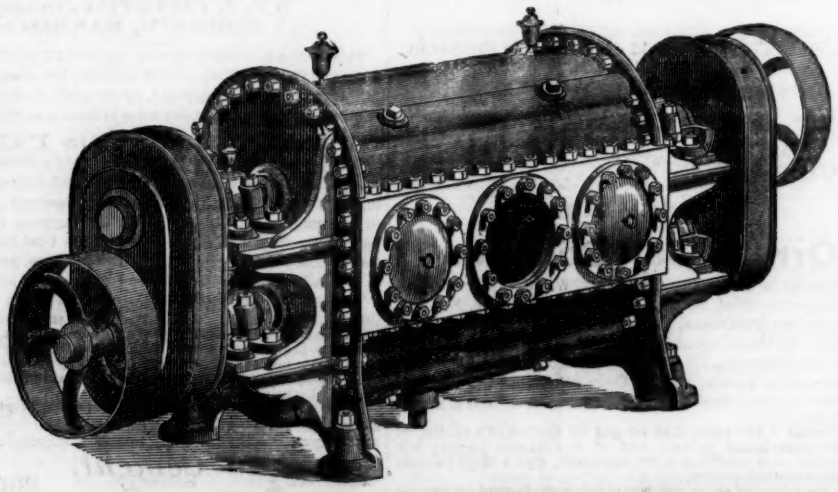
We refer to the following named Gas-Light Companies among the many that have used these Valves:

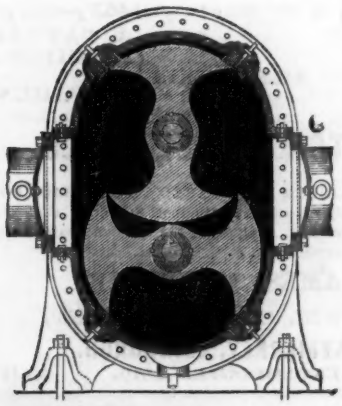
BOSTON GAS-LIGHT COMPANY, BOSTON, MASS.
CAMBRIDGE GAS-LIGHT COMPANY, CAMBRIDGE, MASS.
NEWTON & WATERTOWN GAS-LIGHT CO., WATERTOWN, MASS.
LAWRENCE GAS-LIGHT COMPANY, LAWRENCE, MASS.
PEOPLES GAS-LIGHT COMPANY, BROOKLYN, N. Y.
CITIZENS GAS-LIGHT COMPANY, BROOKLYN, N. Y.
SOUTH BOSTON GAS-LIGHT COMPANY, BOSTON, MASS.
CHARLESTOWN GAS-LIGHT CO., CHARLESTOWN, MASS.
LYNN GAS-LIGHT COMPANY, LYNN, MASS.
FITCHBURG GAS-LIGHT COMPANY, FITCHBURG, MASS.
CITIZENS GAS-LIGHT COMPANY, NEWARK, N. J.
WILLIAMSBURGH GAS-LIGHT CO., WIRLIAMSBURGH, N. Y.

GAS AND WATER VALVES ½ INCH TO 36 INCHES DIAMETER.
STEAM VALVES ½ INCH TO 12 INCHES DIAMETER.

357-tf

PATENT IMPROVED GAS EXHAUSTER.





P. H. & F. M. ROOTS, PATENTEES AND MANUFACTURERS, CONNERSVILLE, IND.
S. S. TOWNSEND, GENERAL AGENT, 31 LIBERTY STREET, NEW YORK.

The following are some of the advantages we claim for this Exhauster over all others:

FIRST.—It is simpler in its mechanical construction than any other Exhauster in use.

SECOND.—The internal parts consist of only two revolvers, each cast entire in one piece, without a single screw, bolt, nut, washer, key or other part to get loose on the inside and stop or break the machine. The internal operating parts, therefore, can not get out order and hence require no care or attention.

THIRD.—Every part of the machine requiring care or attention, as the journals, gearing, etc., is external, easily observed and attended to. All changes, adjustments, and repairs are made from the outside. The journal bearings, if necessary, can be renewed in a few minutes.

FOURTH.—The internal operating parts are practically gas-tight, but are not in actual contact, hence there is no internal friction or wear. The machine is therefore operated with less power than any other.

FIFTH.—They are built in the most complete and substantial manner, with steel shafts and improved journal bearings, and their durability is almost without limit.

We build them of any required capacity, large or small, adapted to any kind of works or place.

Send for Illustrated Catalogue, giving all particulars as to capacity, speed, power required, dimensions, and price of each size and references to parties using them.

P. H. & F. M. ROOTS.

GAS COALS.

THE
PENN GAS COAL COMPANY

OFFER THEIR

COAL, CAREFULLY SCREENED,

AND PREPARED FOR

GAS PURPOSES.

Their Property is located in the Youghiogheny Coal Basin, near Irwin's and Penn Station, on the Pennsylvania Railroad, and on the Youghiogheny River.

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Greenwich Wharves, Delaware River.
366-1y **Pier No. 1 (Lower Side), South Amboy, N. J.**

CANNELTON COAL CO.

OF WEST VIRGINIA.

Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County, West Virginia, delivered at RICHMOND, Va.:

CANNELTON CANNEL,

cknowledged to be the most valuable ENRICHER produced in this country, a gross ton yielding 10,000 ubic feet of GAS of 64·54 CANDLE POWER; COKE 32 bushels, of good quality.

CANNELTON CAKING COAL.

Volatile Matter.	Coke.	Per cent. of Ash in		Sulphur in			Specif. Gravity.	
		Coal.	Coke.	Coke.	Oötl.	Volatile Matter.	Coal.	Gas.
35.1	64.9	2	6	.82	1.48	.66	1.289	.476

MAXIMUM YIELD, 5.06 cubic feet of Gas per pound of Coal—A yield of 4·78 cubic feet per lb.. —gave 16 14-100 Candle-Power.

COKE, of very fine quality—1453 pounds produced from one ton of coal.

SALES AGENTS { J. TATNALL LEA, Treasurer, P. O. Box 1747 Philadelphia.
PERKINS & JOB, 27 South Street, N. Y.; 91 State Street, Boston.
H. W. BENEDICT & SON, New Haven.

SCOTCH CANNEL COALS.

THE SUBSCRIBER IS PREPARED TO CONTRACT FOR the supply of all the principal SCOTCH CANNEL COALS. Prices and Analyses of the various Coals will be forwarded on application.

JAMES McKELVIE,

CANNEL COAL MERCHANT,

HAYMARKET, EDINBURGH.

ESTABLISHED 1840. 357-1y

WREN'S GAS WORKS.

W. C. WREN,

Corner of Jay and Water Streets,

BROOKLYN. N. Y.

HAVING GRANTED THE USE OF ONE OF my Patents to the Gas-Light Company o America, and settled my claim against them, I inform the profession that I continue to erect the Works known as

Wren's Gas Works,

and sell Licenses to use my Patents for making Gas from Petroleum.

Gentlemen of the profession:—As your consumers demand a better light, and as that demand has been in many cases sought in vain to be met by using different abortive imitations of my various processes, would it not be well to make success sure by trying the plan of the inveptor.

You can enrich your Coal Gas to any desired standard, by using my process, in the simplest manner, and much cheaper than by *any other* method. Address as above. 397

THE NEWBURGH

Orrel Coal Company,

Mines at Newburg, Preston County, W. Va.

Company's Office, No. 52 S. Gay Street, Baltimore, Md.

C. Oliver O'Donnell, Pres't. Chas. Mackall, Sec'y.

Chas. W. Hays, Agent in New York, Room 7, Trinity Building, 111 Broadway.

Sinclair & Agnew, Agents, Alexandria, Va.

This Company offer their very superior Gas Coal at lowest market prices.

It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,793 cubic feet, with a large amount of coke of good quality.

It has been for many years very extensively used by various Gas Companies in the United States, and we beg to refer to the Manhattan, Metropolitan, and New York Gas Light Companies of New York; the Brooklyn and Citizen's Gas Light Companies of Brooklyn, N. Y.; the Baltimore Gas Light Company of Baltimore, Md., and the Providence Gas Light Company, Providence, R. I.

Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.

294-1y B

THE DESPARD COAL COMPANY

OFFER THEIR SUPERIOR

DESPARD COAL

To Gas Light Companies throughout the country.

Agents, PARMELEE BROTHERS, No. 32 Pine street, N. Y.

BANGS & HORTON, No. 31 Duane street, Boston.

Mines in Harrison County, West Virginia.

Wharves Locust Point, Company's Office, 15 German St., } Baltimore.

Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine.

*** Reference to them is requested. 304-1y

NEW YORK AND CLEVELAND
GAS COAL COM'Y

Of Pittsburgh, Pa.

MINERS AND SHIPPERS OF

YOUGHIOGHENY GAS COAL.

This Company is prepared to furnish any amount of their justly celebrated, and acknowledged superior GAS COAL, to any point reached by railroad or navigation, on most favorable terms.

General Office—384 Penn Avenue, PITTSBURGH, PA.

Branch Office—C. & P. RR. Coal Pier, CLEVELAND, OHIO.

WILLIAM A. McINTOSH, President.
A. CARNEGIE, Vice-President.
W. P. DE ARMIT, Treasurer.
THOMAS AXWORTHY, Agent at Cleveland, Ohio.
W. H. WATERBURY & CO., General Sales Agents,
351-1y 137 Broadway, New York.

PEYTONA
CANNEL COAL

From West Virginia.

Yields over 13,000 feet of Gas per ton. At ten thousand feet (standard yield) the illuminating power is over 43 candles. Purifies 4,510 feet to the bushel of lime.

S. E. LOW, Secretary,
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OFFICE OF THE

NATIONAL COAL GAS COMPANY,

No. 4 Warren Street, New York.

H. P. ALLEN, President.
I. B. BRICE, Vice-President.
A. H. ALLEN, Secretary.
WM. J. VALENTINE, Treasurer.
GEORGE W. HARRIS. Engineer.

This Company is the owner of the GWYNNE-HARRIS, or AMERICAN HYDROCARBON process, for making Gas for Lighting or Heating purposes, by the perfect decomposition of superheated steam, under what is known as the

GWYNNE AND HARRIS PATENTS.

This process has been fully tested nearly 50,000,000 cubic feet of Gas having been made under it, and fully demonstrating the fact that it is the greatest improvement ever made in the manufacture of Gas, either for Lighting or Heating purposes. With half a ton of Anthracite Coal 150,000 cubic feet of Gas per day is made from three benches, and the labor is so small that one man can attend three or four benches.

The process can be put into either Coal or Oil Gas Works (or where both Coal and Oil are used) at small cost, without any interruption to the working of other benches. The Citizens Gas-Light Company of Brooklyn, after using it for more than seven months, have found it not only far better, but actually *cheaper* than atmospheric air in making Gas, with the use of "petroleum and its products."

Further information, and terms of sale of rights will be given, upon application to the Company 348-1y

Portland Cement,
Roman Cement,
Keene's White Cement,

Numbers 1 and 2.

From best London Manufacturers.

FOR SALE BY

S. L. MERCHANT & CO.,

76 South Street, New York,

Corner Maiden Lane. 344-1y

☞ Remit 10 cents postage for "Practical Treatise on Cement."

B. E. CHOLLAR,
GAS ENGINEER,

914 OLIVE STREET, ST. LOUIS, MO.

325-

THE WAVERLY COAL AND COKE CO.

Offer for Sale the

YOUGHIOGHENY COAL

DOUBLE SCREENED,

from their Colliery at Smith's Mills, on the Youghiogheny River, thirty-seven and a half miles southerly of Pittsburgh. This Coal has the preference in Pittsburgh over all other YOUGHIOGHENY COAL for GAS PURPOSES.

The facilities of the WAVERLY COMPANY are unsurpassed by those of any other Company on the Youghiogheny.

Full particulars can be had by addressing

PERKINS & JOB, Agents,
27 South Street, New York.
91 State Street, Boston.

REMOVAL.

BUTLER'S PATENT
Coke and Coal
SCREENING SHOVELS

MADE FROM BEST MALLEABLE IRON AND STEEL.

FURNISHED WITH LONG OR D HANDLES

Perfect in their operation, is very strong, and from their great durability vastly more economical than any substitute. Refer to all the principal gas Companies in the country, who acknowledge them as the "ne plus ultra of Coke Screening Shovels.

Ordersaddressed only to

HERRING & FLOYD,
Sole Agents,
740 Greenwich St., N. Y.

☞ I still retain the original SABBATON LETTERS PATENT, and have granted no rights or privileges to any other parties.

FOR SALE,

A HALF INTEREST IN A SMALL GAS WORKS WILL be sold. or leased to a practical gas man. Two thousand feet of natural gas per day. Address

J. SHACCKETON,
405-tf Westfield, N. Y.

Gas Engineers,

AND PARTIES ENGAGED IN THE BUILDING OF

GAS WORKS,

who desire information regarding PETROLEUM GAS, either for use pure or for enriching, are requested to address, stating particulars.

J. D. PATTON,
363-unl Treverton, Northumberland Co. Pa.

FOR SALE,

200 Tons
CANNEL CHIPS.

Address H. E. HOY,
34 New Street, N. Y.

NEW YORK SHOVEL WORKS.

MANUFACTURERS OF

SHOVELS, SCOOPS & SPADES.

SHOVELS AND SCOOPS A SPECIALTY

For Gas-Light Companies.

DEAN'S PATENT

COKE SCREENING SCOOPS.

Frames are 12 by 18 inch, seven bars, best Malleable Iron. They can be mad to screen any size desired.

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CORNER OF

GREENE AND ESSEX STREETS,

JERSEY CITY, N. J.

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Clay Gas Retorts,
Gas House Tiles,
Fire Bricks, Etc. Etc.
Ground Clay, Fire Brick and Fire Sand in Barrels,

ALWAYS ON HAND.

J. H. GAUTIER.
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RILEY A. BRICK & CO.,

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CAST IRON PIPES,

FOR WATER AND GAS,

ALSO,

GAS WORKS AND MACHINERY CASTINGS

OF EVERY DESCRIPTION,

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CHAS. H. MEYER & CO.,

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IMPORTERS OF

LAVA TIPS AND SCOTCH TIPS.

ALL ORDERS DELIVERED FREE TO NEW YORK.
359-1y

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American Meter Co.—West 22nd st., N. Y., Arch and 22d st., Phil., 548 Washington st., Boston.
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Cast Iron Gas and Water Pipes—R. D. Wood & Co., Philadelphia Pa.
Cast Iron Gas and Water Pipe—McNeal & Archer, Burlington, N. J.
Franklin Foundry and Pipe Works—Jas. Marshall & Co. 23 Nineteenth street, Pittsburgh, Pa.
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Gas Purification—St. John and Cartwright.
Gas Meters, etc.—Harris, Griffin & Co., 12th and Brown streets, Phila.. Pa.
Gas Meters, etc.—Wm. W. Goodwin & Company, 1012 Filbert street, Phila, Pa.
Gas Meter Manufacturers—Harris & Bro., 1117 Cherry st., Philadelphia, Pa
Gas Fixtures, Etc.—Mitchell, Vance & Co., 597 Broadway
Gasholders, Etc.—Deily & Fowler, 39 Laurel st., Phila., Pa.
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Patent Gas Exhauster—Smith & Sayre, 95 Liberty sttreet.
Pelouze & Audouin Condenser—Jas. R. Smedberg, Sole Agent for U. S. San Francisco, Cal.; Henry Cartwright, 2107 Green street, Phil. Pa.
Petroleum Gas—J. D. Patton, Treverton, Pa.
Patent Gas Exhauster—S. S. Townsend, Agt., 31 Liberty street, N. Y.

GAS COALS

Cannelton Coal Co. of West Virginia—J. Tatnall Lea 325 Chestnut street, Phila, Pa.
Despard Coal Co.—Parmelee & Bros. Agents 32 Pine st. New York.
Gas Coals—Perkins & Job, 27 South st. ,N. Y.
New York and Cleveland Gas Coa Company—384 Penn Avenue, Pittsburgh, Pa.
Penn Gas Coal Co.—11 Merchants' Exchange, Phil. and 90 Wall street, N. Y.
Peytona Cannel Coal—S. E. Low, 58 Broadway, N. Y.
The Newburg Orrel Coal Co.—Chas. W. Hays, Agent in New York, Trinity Building, 111 B'way, Room 7.
Tyrconnell Gas Coal—52 S. Gay Street, Baltimore, Md.
Yougheogheny Coal—Perkins & Job, 27 South St N. Y.
Scotch Cannel Coals—James McKelvie, Cannel Coal Merchant, Haymarket, Edinburgh.

FOUNDRIES.

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Cast-Iron Pipes and Fittings—B. S. Benson, 52 East Monument street, Baltimore, Md.
Continental Works—T. F. Rowland, Greenpoint.
Camden Iron Works, Camden, N. J.—Jesse W. Starr & Son.
Gloucester Iron Works—J. P. Michelion, Sec., 6 North 7th street, Phila., Pa.
Mill Street Foundry.—Geo. Stacey & Co., Cincinnati, O.
National Foundry and Pipe Works—Wm. Smith, Carroll, Pike, Smalliman & Wilkins streets, Pittsburg, Pa.
Oregon Iron Foundry—Herring & Floyd, 740 Greenwich street, N. Y.
Pascal Iron Works—Morris, Taskar & Co., Philaadelphia.
Providence Steam and Gas Pipe Co., Providence, R. I.—H. A. Branch, Agent.

WATER METERS, PUMPS, ETC.

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CLAY RETORT WORKS.

B. Kreischer & Son, Clay Retorts, etc., 58 Goerck st., N. Y.
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Philadelphia Fire Brick Works, Vine and 23d sts., Phila,
Clay Gas Retorts, etc., etc.—J. H. Gautier & Co., cor Greene and Essex streets, Jersey City, N. J.

LAMPS, STOVES, PETROLEUM, ETC.

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MISCELLANEOUS.

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Gas Engineer—B. E. Chollar, 914 Olive St., St. Louis, Mo.
Gas-Light Company of America, 62 and 64 Drexel Building, New York.
Kidd's Gas Consumers Guide—A. M. Callender & Co., 42 Pine Street, N. Y.
Massachusetts Institute of Technology—Samuel Kneeland Boston, Mass.
National Coal Gas Company—H. P. Allen, 4 Warren st., N. Y.
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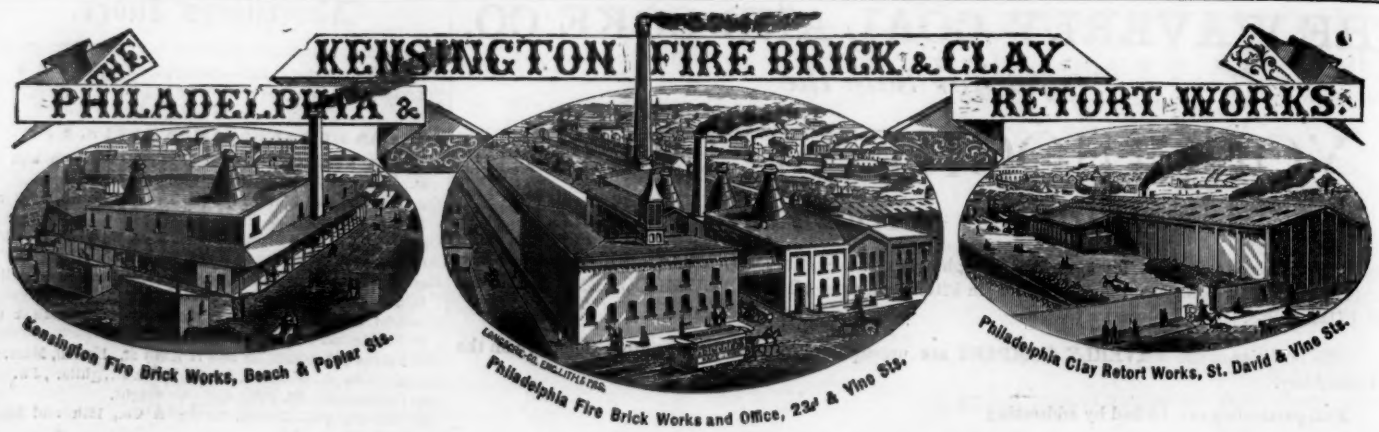
Screening Shovels—A. See & Son, 1358 Broadway, N. Y
Screening Shovels—Torrance, Merriam & Co., Troy, N. Y.
Wren's Gas Works—Cor. Jay and Water sts., Brooklyn, N. Y


THE PHILADELPHIA &
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PHILIP NEUKUMET,

(SUCCESSOR TO JOHN NEUKUMET),

Manufacturer of Fire Bricks, Tiles, Gas and Sugar House Retorts.

☞ Plans of Settings for Benches of Threes, Fives, and Sixes furnished, free of charge, upon application.

M'NEALS & ARCHER,

BURLINGTON. N. J,

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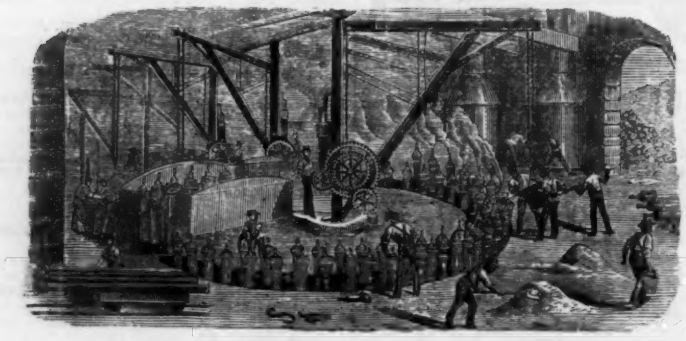
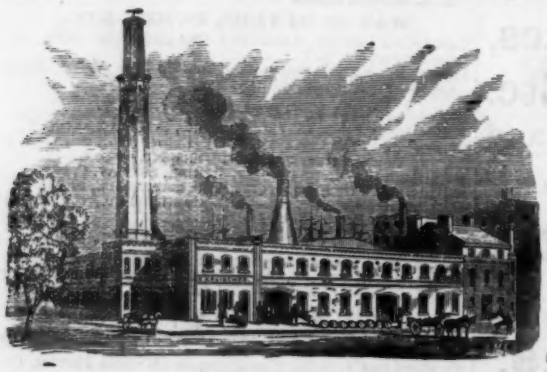


General Foundry Work.

CAST IRON PIPES

FOR WATER AND GAS.



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☞ *Established in 1845.* ☜

(Branch works at Kreischerville, Staten Island.)

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OFFICE,

58 Goerck Street, cor. Delancy, N. Y

GAS RETORTS, TILES & FIRE BRICK

Of all shapes and sizes.

FIRE MORTAR, CLAY AND SAND.

Articles of every description made to order at the shortest notice.

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BENJAMIN CHEW, Treas. WILLIAM SEXTON Sup't.

CAST IRON GAS AND WATER PIPE.

Cast Iron Heating and Steam Pipe. Stop Valves, water or Gas.

Fire Hydrants,

GAS HOLDERS

MANHATTAN

FIRE BRICK & ENAMELLED CLAY

RETORT WORKS.

ADAM WEBER,

(Successor to MAURER & WEBER.)

PROPRIETOR.

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Manufactures of

FIRE BRICK AND TILES,

Of all shapes and sizes.

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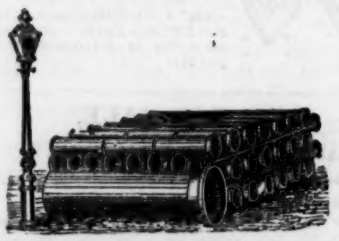

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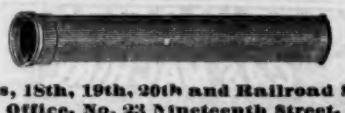

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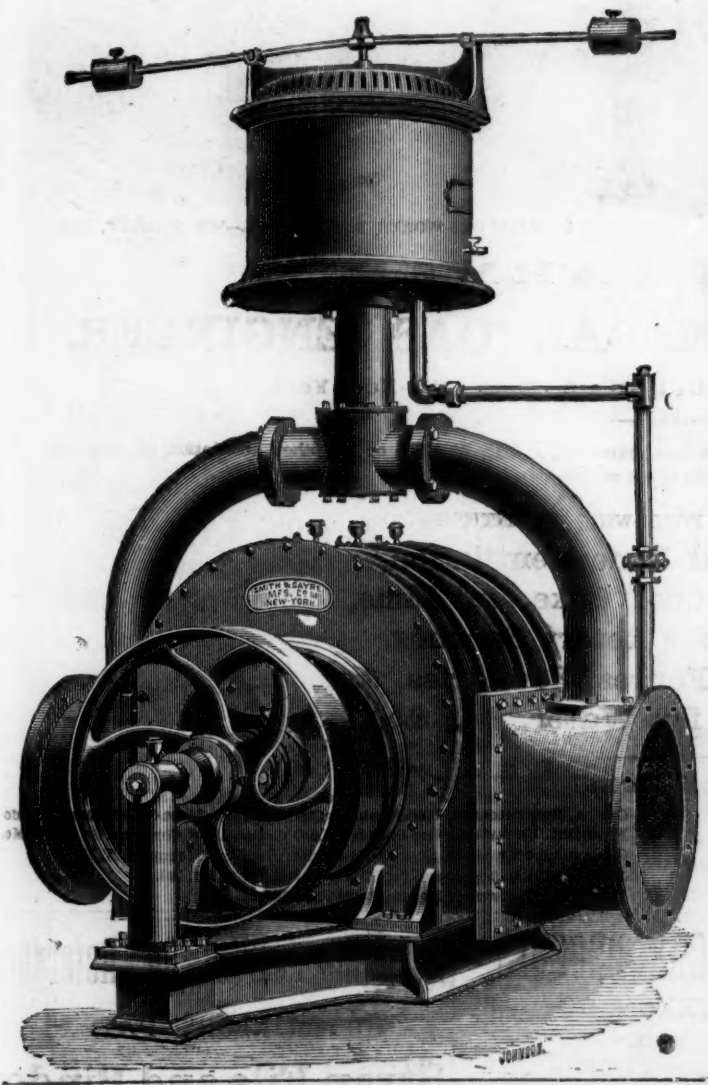

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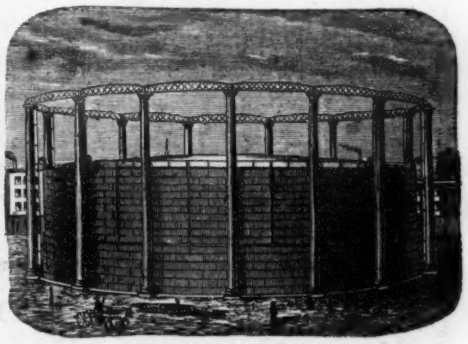

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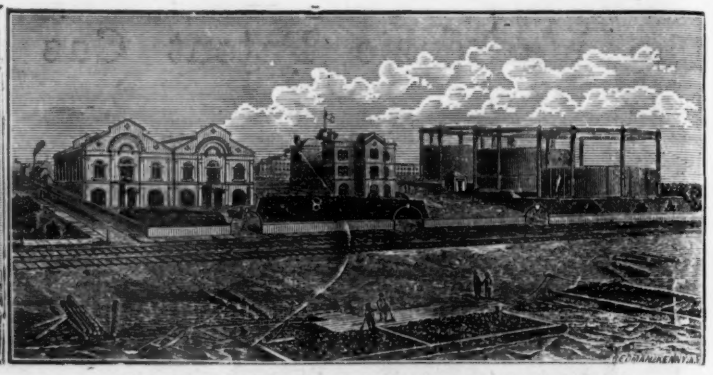

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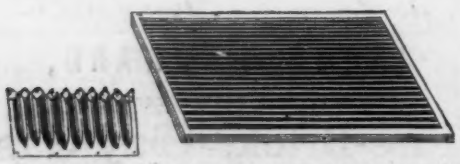

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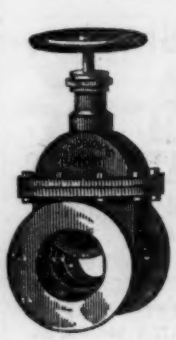

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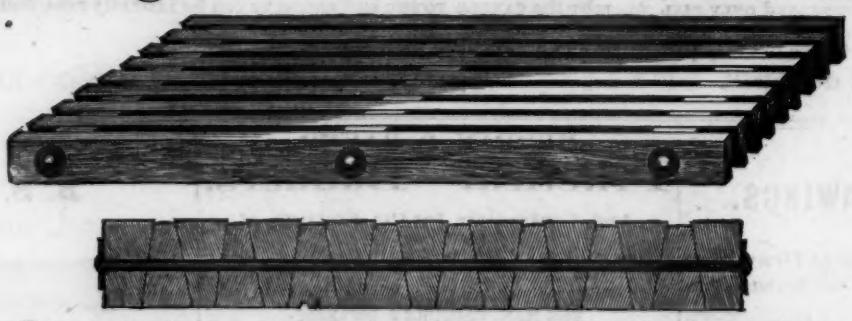

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